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IMPLICATIONS OF WIDE-SCALE CROPLAND RESTORATION

A Crucial Element of the Forest Landscape Restoration Approach

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HIGHLIGHTS

- Achieving the restoration targets set by the Bonn Challenge using the forest landscape restoration approach can generate significant multiple benefits, including a reduction in malnourished children from three to six million; a reduced number of people at risk of hunger estimated to be between 70 and 151 million; reduced pressure for expansion of cropland; increased soil fertility; and reduced greenhouse gas emissions, while also increasing yields and productivity.
- The agriculture-forest interface is the key to achieving global restoration goals. The benefits to farmers and to the broader population suggest that the inclusion of cropland in restoration efforts can facilitate the implementation of restoration plans on large amounts of land.
- Countries can invest in wide-scale restoration projects without jeopardizing food security goals. The forest landscape restoration approach avoids trade-offs between restoration and food production and provides a framework to build on the synergies of multifunctional landscapes with significant benefits to food security.
- Policy makers must invest in well-functioning extension services so farmers can make full use of restorative agronomic practices and agroforestry and silvopastoral systems. Furthermore, there is clear need for transparent and equitable policies that create an unbiased competition between the use of chemical inputs and alternative solutions to increasing land productivity.
- Sufficient resources must be invested in studying the systems that work best given local specific geophysical, climate, and socioeconomic conditions and in developing the models that can facilitate the type of long-term planning horizon required for an adequate management of landscape restoration approaches.
- Finally, harmonizing forestry and agriculture policies and programs is fundamental for designing and implementing integrated landscape approaches and will be imperative to address the underlying causes of land degradation and deforestation.

BACKGROUND

It is well known that land and forest degradation have many impacts on the environment generating significant risks to people, particularly in rural and poor countries, and posing a substantial challenge to meeting global food needs. It is estimated that the global cost of land degradation due to land-use change and to the use of land-degrading management practices is about US$300 billion annually (Nkonya, Mirzabaev, and von Braun 2016) and that, if the current pace of land degradation were to continue over the next 20 years, it could reduce global food production by as much as 12 percent and increase the price of some commodities by as much as 30 percent (IFPRI 2012). Given its magnitude, the problem of degradation must be addressed globally. The governments, communities, businesses and international organizations have advocated in favor of halting land and forest degradation for decades. The latest initiative, the Bonn Challenge, is a global effort to bring 150 million hectares of the world's deforested and degraded lands into restoration by 2020 and 350 million hectares by 2030.

However, even though it is often said that actions that transform degraded lands into healthy landscapes are less costly than taking no action, significant forces have prevented progress and the achievement of land and forest restoration goals. Economic factors (e.g. availability of labor force and mechanization and the opportunity cost of restoration choices) might make restoration a nonviable proposition. Insecure property rights and land and tree tenure might make rural households unwilling or unable to invest in potentially risky restoration activities (Bewket 2007; Enfors and Gordon 2008; Shiferaw, Okello, and Reddy 2009; Teklewold and Kohlin 2011; Bryan et al. 2013; Mungai et al. 2016). Large-scale restoration is not normally practiced by communities living in degraded landscapes even though localized successes

do exist. Many national forest strategies have focused exclusively on how to best manage and protect intact areas of forest and concentrate restoration activities on the establishment of industrial plantations. In doing so, they have often alienated local communities and have not received the support needed to succeed (Rietbergen-McCracken, Maginnis, and Sarre 2007). Even in successful cases, such as the ones reported by Lamb, Erskine, and Parrotta (2005), key limitations are found in the high costs and the limited supply of significant volumes of commercially useful goods (Erskine 2002).

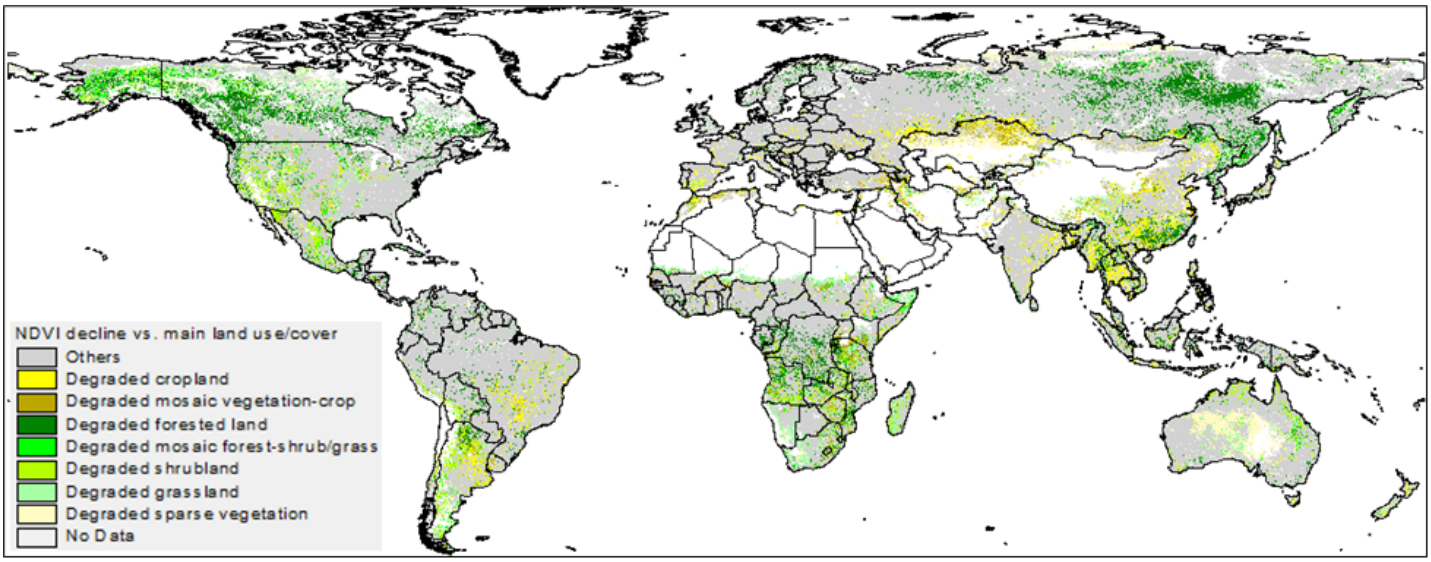
In answer to these long-standing problems are approaches based on the management of landscapes. The forest landscape restoration approach (FLR), in particular, provides a framework that implements sustainable forest management, while creating a substantial role for agriculture. The FLR approach aims at restoring ecological integrity, while also improving human well-being in deforested and degraded landscapes (Rietbergen-McCracken, Maginnis, and Sarre 2007). The active role of agriculture in restoration efforts is expected to favor the engagement and participation of communities thereby reducing opposition to restoration projects and contributing to increasing long-term production and food security out-looks. Evidence shows that landscape-level interventions, such as restoration of riparian areas and wetlands to regulate water flows for agriculture or management of tree cover both within farmland and on surrounding landscapes, can enhance the provision of ecosystem services and support functionality of agriculture landscapes (Harvey et al. 2014 Reij, Tap-pan, and Belemvire 2005; Reij, Tappan, and Smale 2009; Garrity et al. 2010).

Given the key role that agricultural land and crop production plays in the forest landscape restoration approach, a group of researchers at the International Food Policy Research Institute and the International Union for the Conservation of Nature set out to explore the potential effect of agricultural involvement in restoration efforts on agricultural production, food prices, and food security.

METHODS

The authors use a combination of several datasets and modeling outputs: the assessment of global land degradation by Bao, Nkonya, and Mirzabaev (2016); the Spatial Production Allocation Model (SPAM; You et al. 2006); the Decision Support System or Agrotechnology Transfer (DSSAT; Jones et al. 2003); and the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT vers. 3.3; Robinson et al. 2015) to assess the potential benefits of a globally widespread adoption of forest landscape restoration. In the first step of modelling, datasets from the Bao, Nkonya, and Mirzabaev and the SPAM model are used to identify the land that is a candidate for forest landscape restoration. Once the candidate area has been selected, the three scenarios (business as usual [BAU]), lower-bound scenario (minimum involvement of agriculture in FLR), and upper-bound scenario (maximum involvement of agriculture in FLR) are generated using input from the DSSAT model. The DSSAT crop model evaluates yields with current agricultural practices and yields with alternative management practices. The changes in yields are used in the IMPACT model to compute global changes in prices and ensuing effects on food security for 2010–2030. All scenarios assume that agriculture is developing under climate change conditions. Because of the significant role that the Bonn Challenge plays in addressing degradation globally, the researchers used its restoration commitment (move 350 million hectares of degraded and deforested land into restoration by 2030) as a benchmark for the study.

Degradation hotspots by land cover and use types



Source: Bao, Nkonya, and Mirzabaev 2016. Note: NDVI = Normalized Difference

SCENARIOS

Barriers to adoption and the realities of each country's political economy make it impossible to determine a priori how much cropland will ultimately be part of forest landscape restoration efforts and if the emphasis of restoration projects will be on restoring forest or agricultural land. Therefore, two scenarios alternative to a BAU scenario were generated to provide a lower and upper bound of the impact that restoration cropland would have on food security.

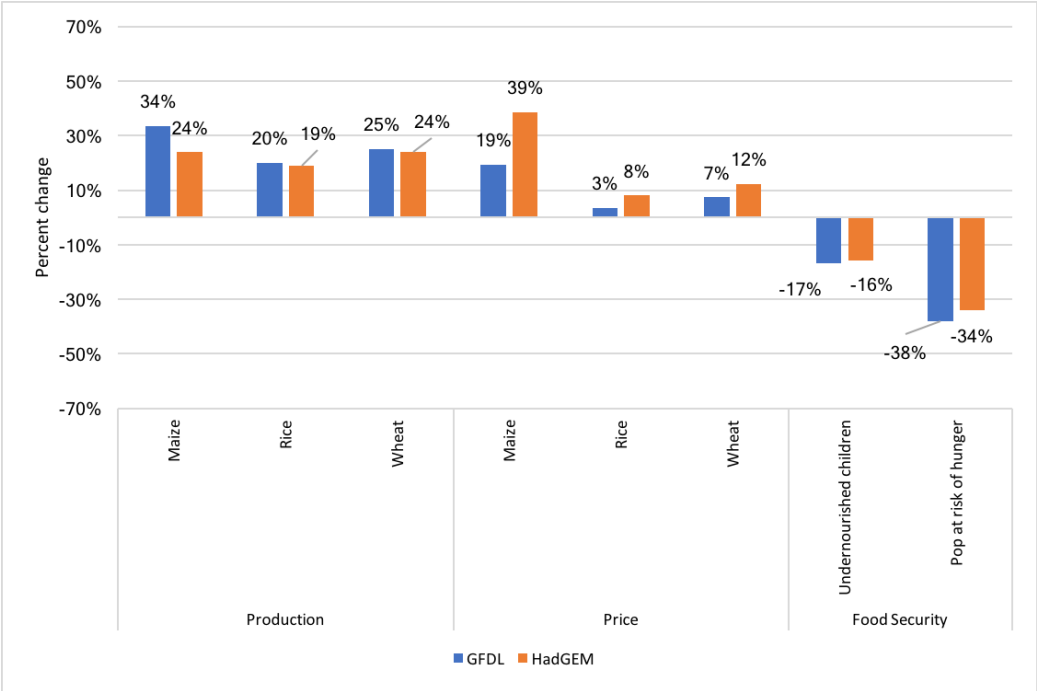
The BAU scenario makes assumptions regarding GDP, population, and agricultural productivity growth without adoption of climate-smart practices. This scenario reflects the use of current practices and technologies throughout the simulated period of 2010–2030. It also includes information on representative cultivars, planting density, planting and harvesting dates, tillage practices, irrigation schemes, and residue harvest rates.

Both alternative scenarios assume that forest landscape restoration efforts can take place on any of the degraded area identified by Bao, Nkonya, and Mirzabaev (2016) that contains agriculture. The first alternative scenario (lower-bound scenario) minimizes the amount of agricultural land involved in forest landscape restoration efforts. The second scenario alternative to the BAU, the upper-bound scenario, assesses the maximum benefits from implementing restoration practices on degraded cropland selecting the area where the restoration practices considered would return the highest gross revenue. The analysis focuses on crop production, particularly on the crops that according to the analysis are most frequently present in degraded areas: maize, wheat, and rice, which represent about 41 percent of the global harvested area and are important staple crops. For these crops, a set of agricultural practices that are thought to have the potential to be adopted widely was considered. The technologies considered for maize and wheat are no tillage, integrated soil fertility management, and nitrogen-use efficiency for rice. The practices are known to restore soil fertility and lead to sustainable production under changing climate regimes and are therefore good complements to the forest landscape restoration approach.

RESULTS

The lower bound scenario represents an implementation of the forest landscape restoration approach that includes (and attempts to minimize) the amount of agricultural area involved in restoration. Results indicate that 63.0 million hectares of cropland (approximately 5 percent of global harvested area) and 97.1 million hectares of pastureland would be present in areas targeted for restoration. The total amount of forest present in this area is 196.8 million hectares (7.2 percent of global forests), 93 million hectares of which is classified as tropical forest (7.1 percent of global tropical forests).

Lower-bound scenario: 2010–2030—Changes in production, prices, undernourished children, and population at risk of hunger

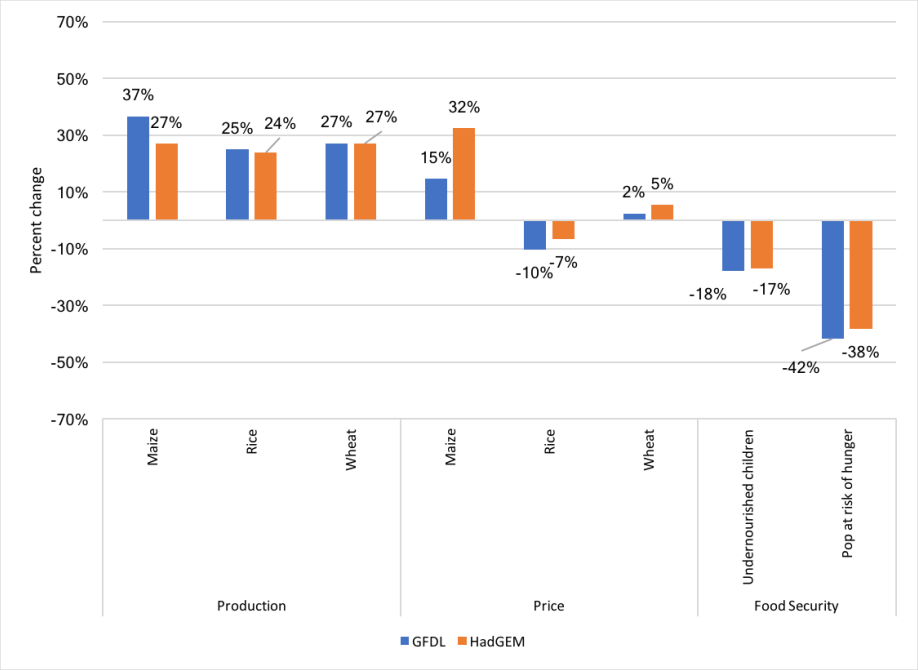


Source: Authors.

According to these simulations, production increases more than projected by the BAU scenario (about 3 percent for maize, 5 percent for rice, and 2 percent for wheat). Commodity prices are still projected to increase, though they are less than the projections in the BAU scenario (5 percent less for maize, 18–19 percent less for rice, and 6–7 percent less for wheat). The compounded effect of higher production and lower prices increases the availability and accessibility of these food staples, with a consequent projected reduction in the number of undernourished children and the population at risk of hunger as compared with BAU. The number of undernourished children is reduced by an additional 1 percent (3,000,000 children) and the population at risk of hunger by an additional 4–5 percent (70,000,000–77,000,000 people). The combination of higher production and lower prices reduces producers' incentives to expand production areas for wheat and rice. Their harvested area is projected to decrease by 0.8 percent for wheat and 2.5 percent for rice. Area allocated to maize is projected to increase by approximately 0.3 percent, which is likely due to the increase in the demand for food for livestock. Soil organic carbon concentration, is estimated to grow by approximately 0.4 Mg ha^{-1} yr^{-1} over the area that adopts the alternative practices; due to the increases in the efficiency of production, greenhouse gas emissions are expected to be reduced by 0.3 Mg CO2 e ha^{-1} yr^{-1}.

The upper-bound scenario explores the effects of restoration efforts on cropland identified with the objective of maximizing the benefits of including crop production in restoration areas. Results indicate that 148 million hectares of cropland (approximately 12 percent of global harvested area) and 79 million hectares of pastures would be present in areas targeted for restoration. About 70 million hectares of forest (about 2.6 percent of all forests) would also be present in this area; 31 million hectares of the forest are classified as tropical forest (roughly 2.4 percent of global tropical forests). The number of undernourished children is reduced by an additional 2 percent (6,000,000 children) and the population at risk of hunger by an additional 8–9 percent (134,000,000–151,000,000 people).

Upper-bound scenario: 2010–2030—Changes in production, prices, undernourished children, and population at risk of hunger



Source: Authors.

As expected, simulation results indicate that a wider uptake of conservation practices on degraded land would have an even greater effect on production and prices. Production increases by about 6 percent for maize, 10 percent for rice, and 3–4 percent for wheat compared to the BAU scenario; prices increase less than what is projected in the BAU scenario—9–12 percent less for maize, 31–34 percent less for rice, and 11–14 percent less for wheat. The combined effect of higher production and lower prices increases the availability and accessibility of maize, rice, and wheat, with a consequent reduction in the number of undernourished children and in the population at risk of hunger as compared with BAU. Similar to the lower-bound scenario, the incentives to expand production area for wheat and rice are reduced, with their harvested area projected to decrease by about 1.5 percent, and 5 percent, respectively. Area allocated to maize is projected to increase between 0.5 percent and 0.9 percent due to the increase in the demand for livestock feed. Considered all together, total harvested area is projected to decrease. Soil organic carbon concentration is estimated to grow by approximately 0.4 Mg ha^{-1} yr^{-1}, and greenhouse gas emissions are expected to be reduced by 0.2 Mg CO2 e ha^{-1} yr^{-1}

CONCLUSION

The results of this study reveal that the full inclusion of crop production in the forest landscape restoration approach could produce large-scale, worldwide benefits for food security and therefore facilitate a wide uptake of restoration practices and the implementation of large restoration projects. The positive impacts are multifaceted and significant in size: a reduction in malnourished children ranging from three to six million; a reduced number of people at risk of hunger, estimated to be between 70 and 151 million; reduced pressure for expansion of cropland; increased soil fertility; and reduced greenhouse gas emissions, while also increasing yields and productivity. The benefits from restoration practices on crop production strongly suggest that a forest landscape restoration approach that meaningfully integrates agriculture can facilitate the implementation of restoration plans on large amounts of land.

As impressive as these results are, the limits of the modeling employed indicate that these are still underestimates of the full potential of a widespread adoption of restoration practices. Current modeling capabilities prevent us from including the use of agroforestry or agrosilvopastoral systems in the simulated scenarios, indicating that our results are likely to be an underestimation of the full benefits of restoration practices on agricultural land. The role of agricultural land in the proposed approach is key to promoting a wide uptake of restoration efforts. In fact, widespread adoption of restoration practices is possible only if landowners, farmers, smallholders, and land managers benefit from it and only when restoration programs have stakeholder support. The presence of agriculture in restoration areas is expected to promote the active role of communities and a broad implementation of restoration plans.

Countries supporting the Bonn Challenge and other restoration efforts should renew their efforts to ensure that current commitments are met to achieve the significant payoff of their investments. The results of this analysis not only confirm the findings of the many studies that have investigated the benefits of restoration in more localized settings but also should provide enough confidence so that governments and policy makers can answer the many calls to invest in wide-scale restoration projects without jeopardizing their food security goals. Approaches that fully integrate agriculture in restoration projects, such as forest landscape restoration, not only can avoid trade-offs between restoration and food production but also can provide a framework to build on the synergies of multifunctional landscapes with significant benefits to food security. However, the overall positive outcomes are strongly dependent on how widely adopted conservation practices are, which points to the importance for policy makers to find and promote solutions to long-standing problems, such as the need for well-functioning extension services, proper amounts of good-quality information for farmers, and reliable and trustworthy institutions.

Policies and instruments that allow for the proper accounting of social benefits and costs also must be in place to generate an equitable competition between the use of chemical inputs and alternative solutions to increasing land productivity such as agroforestry systems. Without addressing these barriers, farmers will continue to maximize their private short-term benefits, which might conflict with long-term societal goals. Finally, sufficient resources must be invested in studying the systems that work best given local specific geophysical, climate, and socioeconomic conditions and in developing the models that can facilitate the type of long-term planning horizon required for an adequate management of landscape restoration approaches.

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