Carbon Sequestration: Addressing Climate Change and Food Security through Sustainable Agriculture

Christina Ospina

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1400 16th St. NW, Suite 430, Washington, DC 20036

Introduction

To meet the demands of a growing, increasingly urban global population (approximately 9 billion by 2050), the World Bank calculates that global food production must increase by 70% in the next 35 years.[1] This is a great challenge not only because of the volume of food that must be produced, but because agricultural conditions will not remain constant or predicable in the years to come.

It is still unclear how and to what extent climate change will affect agricultural conditions. Some regions might even benefit from climate change, but many estimates already show that overall, climate change is expected to lead to declines in crop yields and increased prices, with a particularly strong impact in developing countries. When approximately 70% of the world's most impoverished people rely on agriculture as their main source of income and employment, the potential impact of climate change on the livelihoods of populations with limited resources is troubling.[2] Many developing countries are already struggling to meet the dietary and economic needs of their populations, making the challenge of feeding the world's population in the face of a changing climate increasingly pressing.

There are, however, many ways in which this challenge could be met. For example, vulnerable populations and developing countries could benefit significantly from new and sustainable farming practices. Facing variable farming conditions in the years to come, these populations would benefit from agricultural practices that would not only increase yields, but also allow for better adaptation to changes in soil quality, precipitation, timing and duration and seasons, and more.

An International Food Policy Research Institute report outlines opportunities for more productive and sustainable farming practices in the face of climate change. This report offered many important recommendations, but most notably highlighted the link between enhanced food security and climate-change adaptation.[3] Sustainable farming has been shown to improve agricultural resilience and increase yields in climates where farming is historically difficult, and even help curb greenhouse gas emissions through practices like soil carbon sequestration. Such practices can not only help in

terms of climate adaptation, but can also be an invaluable driver in reducing poverty around the world.

It is important to note that there is no single method that would best promote productivity in developing countries. Encouraging sustainable agriculture while meeting the basic needs of countries would involve much more than a desire to fight climate change. To make a positive and lasting impact, efforts would require increasing investments in local industry; developing programs that adapt to each region's political, economic, and cultural differences; increased research; better data collection and analysis, and more. Due to the extensive range of factors that involved in promoting food security and sustainable agriculture, this article will focus on the potential for soil carbon sequestration as a sustainable farming strategy that could benefit developing countries.

Sustainable Farming Practices

In recent years, soil has been identified as an underutilized carbon sink, with a great potential to alleviate climate pressure. Soil is normally a significant carbon sink, but land use changes, such as conversion of native lands for agricultural use, reduces the soil's potential carbon storage capacity. Some common agricultural practices, such as tilling, release carbon stored in soil. By contrast, periodically allowing soil to lie fallow leads to increased carbon sequestration.[4]

More and more, scientists and researchers are exploring ways to restore degraded lands and replenish carbon and microbe levels for healthy soil.[5] Carbon is an essential component of soil, giving it better water-retention, structure, and fertility. Improving soil quality around the world is an important step in achieving greater food security, especially in regions where vulnerable populations would benefit significantly from increased productivity and resilience.

One way to both increase crop yields and mitigate greenhouse gas emissions would be through soil carbon sequestration, which is the process by which atmospheric carbon is pulled into and stored in soil. Generally, high soil diversity and reduced disturbance can help maximize soil carbon sequestration. However, restoring degraded systems or preserving native lands are not the only means of enhancing a soil's carbon storage capacity. Several well-known methods for

environmentally responsible farming can help actively enhance storage while introducing other co-benefits as well. Of course, a combination of these methods would lead to the greatest benefit. Other methods should also be explored, as those highlighted below might not necessarily be suited for all countries or regions. Some methods to highlight include:

1) No-till farming helps leave soil undisturbed and would protect sequestered carbon; meaning that it promotes carbon conservation in soil. This faming method is also known for preventing soil erosion, and in some regions, it has shown to help increase crop yields.[6]

2) Crop rotation, which involves the sequential planting several different crops on a plot of land, is a complimentary method to improve soil health. Not only does this method promote a strong balance of nutrients, this method can also reduce weed growth. In terms of carbon sequestration, rotational diversity can allow soil microbes to better process biomass residue that would then be stored in aggregates (stable soil structures that can protect carbon).

3) Livestock is another important component of the agricultural industry, and moving grazing herd animals from pasture to pasture can prevent over-grazing and land degradation. Restoring degraded lands through the introduction of manure could help improve soil quality, thereby improving its ability to store carbon.

4) Perennial crops are those that can survive through multiple seasons and harvests, requiring less disturbance to plant new seeds. Perennial fields have shown to have higher root mass which allows for better introduction of carbon and nutrients back into the soil.[7]

By introducing these sustainable farming methods in regions where a decline in agricultural would have the greatest negative effects on local populations, soil carbon sequestration could be an effective means of enhancing food security and addressing climate challenges.

Investments, Policy Change, and More

While adopting sustainable farming practices is integral to mitigating the climate impact of the agricultural industry and for promoting food security, other factors must be taken into consideration

in order to have a successful model. Steps like increased investments in small farms, disseminating better technologies in developing countries, and promoting government and community involvement are also essential in addressing climate and food challenges.

For example, many of the practices or technologies used in sustainable farming can be costly, putting them out of reach for farmers with limited resources. Additionally, it can be very difficult for new practices to be adopted if farmers are unfamiliar and uncomfortable with these methods. A World Bank report synthesized information from the United Nation and the Food and Agriculture Administration, noting a range of inputs needed to best adopt sustainable practices. These include market access, well-defined land ownership, research, education, and more.

TABLE E4: Relative Importance of Different Factors for Adopting Improved Land Management Practices

LAND MANAGEMENT TECHNOLOGY	INPUTS/ CREDITS	MARKET ACCESS	TRAINING/ EDUCATION	LAND TENURE	RESEARCH	INFRASTRUCTURE
Inorganic fertilizer	***	**	**	**	*	**
Manure	**	**	*	**	*	**
Conservation agriculture	**	**	***	**	**	*
Rainwater harvesting	**	**	**	***	**	**
Cross-slope barriers	**	*	**	**	**	*
Improved fallows	**	*	*	***	**	*
Grazing management	***	***	**	***	**	*

Source: Synthesized from Liniger *et al.* 2011.

Liniger, H. P., Mekdaschi Studer, R., Hauert, C., and Gurtner, M. 2011. Sustainable Land Management in Practice—Guidelines and Best Practices for Sub-Saharan Africa. World Overview of Conservation Approaches and Technologies and Food and Agriculture Organization of the United Nations.
*Key * = Low importance, ** = Moderate importance; *** = High importance.*

To delve into some of the public policies that could help encourage carbon sequestration and climate-smart agriculture more broadly:

1) Governments and institutions should be prepared to increase investments and transform policies to encourage climate-smart agriculture. This could include encouraging people-centered learning approaches, developing culturally and socially sensitive policies that also support marginalized groups, and incentivizing sustainable farming. This could be enhanced further by creating financial or market incentives for private sector investment in these methods.[8]

2) Along with better policies to support marginalized groups, farmers in developing countries should be given better access to tools and trainings. This could include creating better ways for farmers to share and learn new information, depending on the channels that are more effective in each community, and empowering farmers to make informed decisions. This would aid both in addressing knowledge gaps and bolster capacity-building for vulnerable populations.
3) Monitoring and assessing the best tools and practices in sustainable farming is another essential piece in ensuring that the best strategies are employed in each region and that anticipated benefits are achieved. Since new discoveries in sustainable farming are constantly emerging, it is important that each new tool is evaluated in each region to glean best practices and to guide decision-making.

Agriculture Class, by Denise Miller. (CC BY-NC-ND 2.0)

Conclusion

A changing climate introduces many questions and challenges, but also opens opportunities for people around the world to innovate and transform traditions.

So many people around the world rely on agriculture as their source of income, and so many small farms supply families and communities with the most basic food needs. With climate change projected to make farming conditions more variable and less productive, it is especially important to provide vulnerable populations with the tools they need to achieve food security. Simple changes like educating farmers and increasing investments in sustainable agriculture could have a tremendous impact in the developing world. Because of this, embracing soil carbon sequestration and enacting policy changes could be especially effective tools to both increasing resiliency in the agricultural issue and meeting the ever-growing food demands for our population.

Notes

1. *Carbon Sequestration in Agricultural Soils*. The World Bank. Report. 2012. https://openknowledge.worldbank.org/bitstream/handle/10986/11868/673950REVISED000CarbonSeq0Web0final.pdf?sequence=1&isAllowed=y

2. Agricultural and Rural Development. The World Bank. http://data.worldbank.org/topic/agriculture-and-rural-development

3. Nelson, Gerald C. et al. *Climate Cage: Impact on Agriculture and Costs of Adaptation*. International Food Policy Research Institute. Reports. September 2009. http://unpan1.un.org/intradoc/groups/public/documents/icap/unpan037602.pdf

4. Kane, Daniel. *Carbon Sequestration Potential on Agricultural Lands: A Review of Current Science and Available Practices*. Report. November 2015. http://sustainableagriculture.net/wp-content/uploads/2015/12/Soil_C_review_Kane_Dec_4-final-v4.pdf.

5. Schwartz, Judith. *Soil as Carbon Storehouse: New Weapon in Climate Fight?* Yale Environment 360. N.p., 4 March 2014. http://e360.yale.edu/feature/soil_as_carbon_storehouse_new_weapon_in_climate_fight/2744/.

6. *Advancement and impact of conservation agriculture/no-till technology adoption in Kazakhstan*. Agriculture Competitiveness Project. Ministry of Agriculture of the Republic of Kazakhstan. 6 December 2012. ftp://ftp.fao.org/ag/agp/ca/CA_CoP_March13/FAO_Info_note_on_CA_in_Kazakhstan.pdf

7. *Sustainable Agriculture: Perennial Plants Produce More; Landscape Diversity Creates Habitat For Pest Enemies*. Science Daily. Ecological Society of America. 6 August. 2009. https://www.sciencedaily.com/releases/2009/08/090804071358.htm

8. Liniger, H.P., R. Mekdaschi Studer, C. Hauert and M. Gurtner. *Sustainable Land Management in Practice – Guidelines and Best Practices for Sub-Saharan Africa*. TerrAfrica, World Overview of Conservation Approaches and Technologies and Food and Agriculture Organization of the United Nations. 2011. https://www.wocat.net/fileadmin/user_upload/documents/Books/SLM_in_Practice_E_Final_low.pdf.