A "Brown Revolution" for Better Soil Health in Africa

October 9, 2013

Poor and declining soil health threatens Africa's potential for agriculture, poverty reduction, and environmental sustainability.

Three-quarters of soils

suitable for agriculture in Africa have been

significantly degraded.

To achieve food security, Africa needs a **"Brown Revolution"** to rebuild soil health using sustainable practices.

Conservation agriculture

is one context-specific approach

that aims to **increase the productivity and sustainability of agriculture.**

THE ROOT OF THE CHALLENGE

Millions of African smallholder farmers and their families depend on the land for their livelihoods. The quality of the soil is a significant factor in farmers' ability to improve their livelihoods and overall food security. In a world where almost 850 million people are already food-insecure, the challenge of how 9 billion people will sustainably feed themselves in 2050 must be addressed today.[1] Against this backdrop, soil health is crucial to Africa's potential for agriculture and food security. Healthy soil is a necessary building block to agricultural development, achieving robust yields, productive livelihoods, and environmental sustainability.

It can take 500 years or more to produce an inch of topsoil, and yet soil is vulnerable to many risks.[2] Its health demands special attention from policymakers, farmers, development partners, and the private sector. Unfortunately, policymakers in Africa have failed to elevate soil health as a key policy priority, even as the soil beneath farmers' feet becomes increasingly degraded.

Africa faces grave soil health challenges. Some 75% of its agricultural soils have been significantly degraded; as a result, over half of its production zones have serious fertility problems.[3] More than 80% of soils in Africa have chemical or physical limitations that limit crop production.[4] Luc Gnacadja, Executive Secretary of the United Nations Convention to Combat Desertification (UNCCD), has said that the world is being depleted of arable land at 30–35 times historic rates.[5]

These soil challenges are exacerbated by additional threats such as rapid population growth and extreme weather events — the World Bank predicts that rainfall patterns in sub-Saharan Africa will shift, heat extremes will occur more frequently, and dry, arid regions will expand. Consequently, African farmers are expected to see lower crop yields, lose arable land (40–80% of the croplands used to grow maize, millet, and sorghum by some estimates), and have less food available for consumption.[6] These trends may be compounded by a population boom on the continent, with Africa's overall population expected to quadruple within just 90 years.[7]

Weathered, degraded soil is a major contributing factor to stagnant agricultural growth and low yields. Existing fertilizers improve yields on healthy soils, but have little or no success in increasing yields on "dead" soil. Ultimately, improving soil health requires farmers and policymakers to take a long-term approach. Empowering farmers through improved land rights, knowledge, and incentives facilitates the longer-term investment and stewardship required.

THE DIRT ON HEALTHY SOILS

Soil is the thin layer of material on the Earth's surface that is composed of essential organic materials and minerals. Soil is made up of weathered rock, decaying plant and animal matter, and a wide range of living things; a single handful of soil contains as many as a billion different organisms.[8] The Food and Agriculture Organization of the United Nations (FAO) describes soil's two key functions as to "renew, retain and deliver plant nutrients" and to provide physical support to plants.[9]

Unsustainable farming systems contribute to the loss of soil's essential properties, erosion, and degradation. For example, while the plow has become the universal symbol for agriculture, tilling the ground releases carbon from the soil (where it is needed) into the atmosphere (where it is damaging). In the long term, soil disturbance decreases fertility and increases erosion, while energy-intensive inputs do not increase organic matter or the health of the soil.

Conventional tillage methods can decrease yields and diminish soil health over time, as the soil loses the essential nutrients crops need. In some parts of Africa, over-application of fertilizers produces a build-up of unnecessary nutrients, which are harmful to the environment. The practice of slash-and-burn agriculture – cutting and burning of forests or woodlands to create fields – is also harmful to the environment, soil, and health of local populations.

Soil Properties

KEY PROPERTIES FOR SOIL HEALTH INCLUDE:

SOIL ORGANIC MATTER: Soil organic matter is made up of dead plant and animal materials in varying stages of decomposition. It is the decomposition of this matter that provides nutrients and energy to plants.

NUTRIENTS: There are 15 essential nutrients in soil, including carbon, nitrogen, potassium, calcium, and magnesium. These nutrients play a key role in plant metabolism and growth.

SOIL STRUCTURE AND TEXTURE: Soil structure and texture are important for the soil's ability to store water and supply nutrients to plants.

pH: Healthy soil pH is essential for soil nutrient availability and plant biological activity. Acidic soil reduces soil nutrition and plant growth, while salinity degrades soil and limits plant growth and yields.

ONE APPROACH: CONSERVATION AGRICULTURE

Conservation agriculture offers one context-specific response to the challenge of feeding a growing global population in a sustainable way.[10] The approach entails a bundle of practices[11] that involve three primary principles: 1) low or no-tillage; 2) organic soil cover or cover crops; and 3) crop rotation.[12] When farmers use low or no-till methods, they seek to minimize soil disturbance in order to maximize organic matter in the soil, which is an important component in soil fertility. Cover crops are used to provide essential nutrients, protect soil from wind erosion, retain moisture, and reduce soil temperatures by offering shade. Crop rotation is also extremely important. Rotating specific crops can replenish lost nutrients, increase microbial activity, and bolster yields.

While conservation agriculture is not a silver bullet solution to restoring Africa's degraded soils, there are many benefits associated with its context-specific application, including:

SOIL HEALTH: Using no-till or low-till practices minimizes soil disturbance, which maintains the soil's structure, minimizes nutrient loss through erosion, and enhances the growth of mycorrhizal fungi, a type of fungus that symbiotically supports the healthy growth of roots of most plants. Better-quality soil enables higher moisture retention from rainfall, thereby decreasing the danger of water erosion. Another benefit is the potential for conservation agriculture to increase soil carbon sequestration, or the influx of carbon into the soil.[13]

YIELDS: In addition to its impact on soil health and environmental sustainability, the application of conservation agriculture has been documented to increase yields over the long term.[14] In the most comprehensive study to date, researchers examined the impacts of 286 recent sustainable agriculture projects in 57 countries, involving over 37 million hectares of land. They found that these interventions increased productivity on 12.6 million farms, with an average crop increase of 79%. The results were even better for projects in Africa, which showed an increase of 116% (128% for projects in East Africa specifically).[15]

RESILIENCY: There is research indicating that conservation agriculture practices can lead to more reliable harvests during drought years.[16] In some studies, farms using conservation agriculture outperformed conventional tillage by 30%, mainly due to higher levels of water retention.[17]

SAVINGS: Farmers can also save on input costs by avoiding the use of synthetic fertilizer and can save time on labor by not having to weed or till the land.

Conservation agriculture is, however, knowledge-intensive and context-specific. Like all agricultural practices, one size does not fit all, and there is no panacea. Soil is inherently local, and Africa may have the most diverse soil characteristics of anywhere in the world.[18] Effective conservation agriculture systems must be tailored to meet local needs. For example, according to some experts, some 20 different factors

must be taken into account just for selecting the appropriate cover crop systems, including local food preferences, current market conditions, dominant cropping systems, the major weeds in farmers' fields, as well as local economic needs, environmental conditions, and land ownership patterns.[19]

This variability creates practical challenges to the widespread adoption of conservation agriculture. Successful farming anywhere relies upon appropriate inputs, equipment, and extensive local knowledge, and conservation agriculture is no different. Unfortunately, the existing conservation agriculture knowledge base in Africa is more limited than in conventional agriculture. The same can be said for the availability of appropriate equipment, inputs, and technical support.

Without developing this knowledge base and investing in extension services, smallholder farmers will inevitably struggle to successfully adopt conservation agriculture systems, particularly during the initial transition.[20] Farmers must make informed decisions about how to allocate labor, inputs, equipment, time and effort – including inter-temporal trade-offs between immediate and long-term benefits, and such practical trade-offs as using crop residue for crop coverage or livestock feed.[21] A farmer's willingness to change from traditional farming to conservation agriculture could be negatively affected by their perception of these trade-offs. In this way the risk – real or perceived – to a farmer that yields could decrease is a serious challenge to widespread adoption of these practices.[22] The successful adoption of conservation agriculture requires overcoming these systemic and behavioral challenges.

CONSERVATION AGRICULTURE IN PRACTICE

Worldwide, roughly 105 million hectares are farmed using conservation agriculture or no-till farming.[23] In Brazil, for instance, no-till agriculture has contributed to the transformation of the country's agriculture sector and its use has increased dramatically. In 1990, Brazilian farmers used no-till farming for just 2.6% of their grains, compared with over 50% today – a timeframe that corresponds with a 365% increase in Brazil's total crop value.[24]

In Africa, the promotion and adoption of conservation agriculture is mixed. An estimated 400,000 hectares in South Africa are farmed under conservation agriculture systems, while in other sub-Saharan countries large-scale adoption of the method is just beginning. The following are examples of conservation agriculture projects in four sub-Saharan African countries:

MALAWI: In partnership with Irish Aid and the World Agroforestry Centre (ICRAF), the Government of Malawi began a multi-year agroforestry program where farmers were given nitrogen-fixing trees to improve soil quality and thus increase yields.[25] By 2009, over 120,000 farmers had received training and trees, and the program had reached 40% of Malawi's districts and 1.3 million people. Research shows that this approach may result in increased maize yields, from 1 ton per hectare to 2–3 tons per hectare, even when farmers cannot afford commercial nitrogen fertilizers.

SENEGAL: The U.S.'s Feed the Future program in Senegal sought to test the effectiveness of conservation agriculture by conducting an "estimation and comparison" of yields from maize, millet, and sorghum crops, both with and without conservation farming.[26] It found a substantial yield difference between the two methods across four regions that applied conservation agriculture approaches: yields increased by 49% in Kaolack, 26% in Tambacounda, 71% in Fatick, and 25% in Kédougou.

TANZANIA AND KENYA: Nearly 5,000 smallholder farmers in Tanzania and Kenya have adopted conservation agriculture practices following their participation in farmer field schools. FAO found that farmers who adopted conservation agriculture improved their crop yields by between 26% and 100% or more over three to ten years. Adopting farmers also reduced their labor inputs dramatically: farmers who used appropriate direct seeding equipment (a manual "jabber") could plant a field of 0.4 hectares in 3–4 hours compared with conventional tillage where three people worked with hand hoes and required an entire day.[27]

The Bedrock of a "Brown Revolution" in Africa

For too long, soil health has been neglected as part of the agricultural development agenda in Africa. It is time for African leaders to foster a "Brown Revolution" that puts soil health squarely on the agenda. To accomplish this, African leaders and development partners should consider the following recommendations:

AFRICAN GOVERNMENTS SHOULD HIGHLIGHT THE IMPORTANCE OF SOIL HEALTH IN THEIR AGRICULTURE SECTOR STRATEGIES AND DEVELOP RECOMMENDATIONS FOR FOSTERING A "BROWN REVOLUTION." All countries should develop an explicit soil health strategy with specific plans for rebuilding the health of soils. In turn, donors and national governments should ensure that these strategies inform national food security and agriculture plans. These plans should emphasize a range of approaches, including conservation agriculture where appropriate. The Comprehensive Africa Agriculture Development Programme (CAADP) can aid in this effort by identifying and disseminating guiding principles for implementing and scaling up conservation agriculture practices within CAADP countries.

IN ORDER TO ADDRESS ADOPTION BARRIERS FOR SMALLHOLDER FARMERS, GOVERNMENTS AND DONORS SHOULD INCREASE INVESTMENT IN EXTENSION SERVICES AND SUPPORT FOR FARMER ORGANIZATIONS. Proper soil health management requires knowledge – by farmers, policymakers, and researchers. Lack of awareness, capacity and understanding poses a significant barrier to the adoption of conservation agriculture. If extension staff are not familiar with soil management and conservation agriculture techniques, they do not promote them to farmers. It is therefore important for governments to strengthen the capacity and technical know-how of extension staff so that they can impart this knowledge to farmers. Supporting farmer organizations offers another vehicle for spreading information about improving soil health and conservation agriculture. Farmers often learn new practices from peers and neighboring farmers. For this reason, local farmer organizations should be supported, fostered, and endowed with knowledge about the importance of soil health.

GOVERNMENTS SHOULD IMPROVE TENURE SECURITY OVER RURAL LANDS TO ENSURE THAT SMALLHOLDER FARMERS CAN REALIZE INVESTMENTS IN SOIL HEALTH AND CONSERVATION AGRICULTURE.

Smallholder farmers need the guarantee that they will have long-term access to their land. Governments must take steps to provide these guarantees so that smallholder farmers can act as stewards of their land.

LOCAL RESEARCH CAPACITY SHOULD BE STRENGTHENED TO BETTER DETERMINE THE PRACTICES THAT WORK BEST ACROSS THE CONTINENT'S DIVERSE GROWING CONDITIONS.

Efforts to improve soil health, including conservation agriculture, are highly context-specific. For this reason, it is paramount that donors and governments devote resources towards bolstering local research capacity and knowledge. Increased local research will also help complement the emerging evidence base around conservation agriculture in sub-Saharan Africa.

ACKNOWLEDGEMENTS

We would like to thank the Howard G. Buffett Foundation for their support, guidance, and constructive feedback on this report. The writing and analysis of this report were led by Molly Kinder. The management, editing, and production of this report were led by Sara Harcourt, David Hong, and Caitlyn Mitchell. Thanks go to our faithful copy-editor, David Wilson. The report's design and art direction were guided by the talents of Katie Rosenberg and ONE staff Elizabeth Brady and Adrienne Schweer.

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