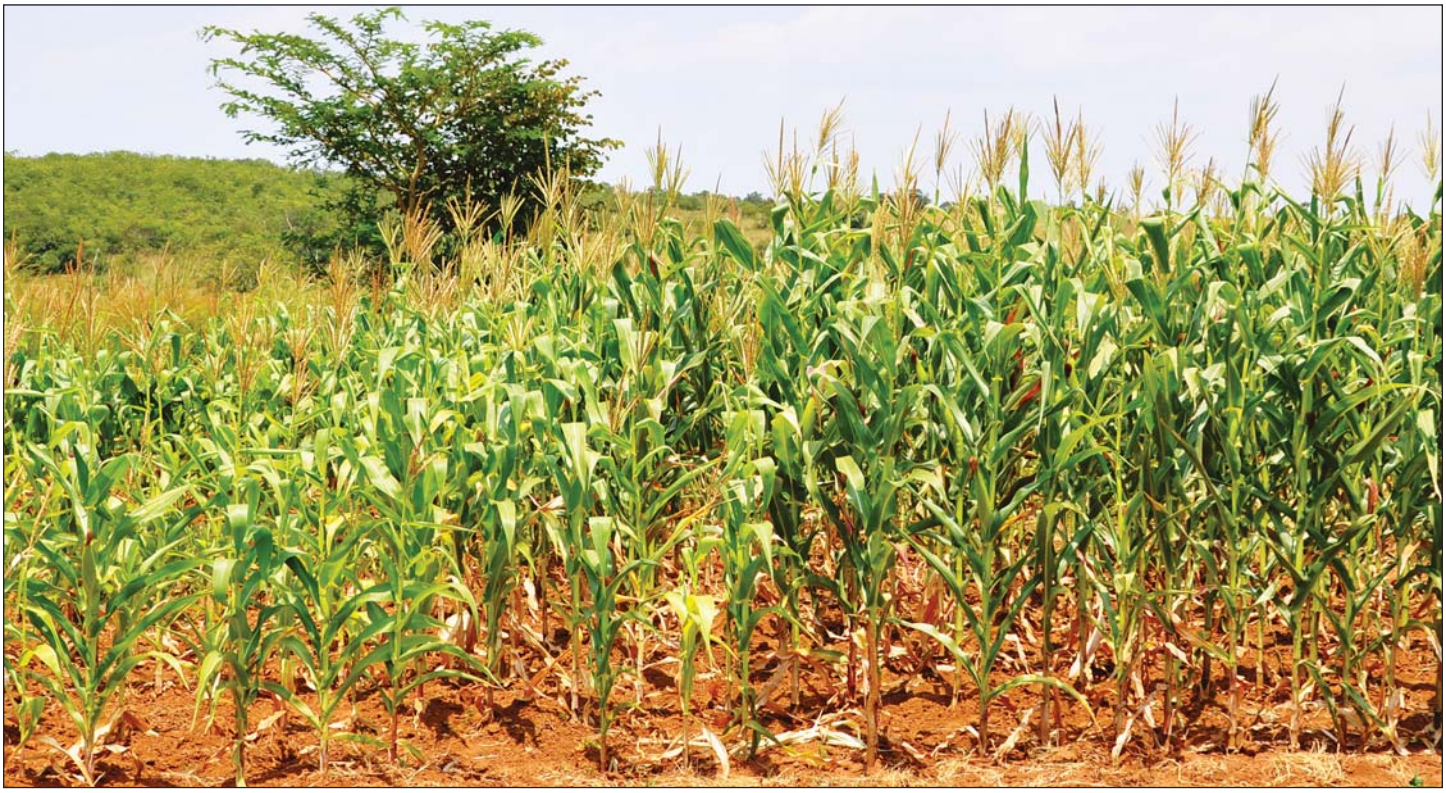
Sustainable Intensification to Protect Soil Resources

By Robert Mikkelsen



IPNI Photo/S. Zingore

Maize yield gap demonstrated in field experiment in Zimbabwe. Control plot on the left versus fertilized NPK plots on right.

Soils have a vital role in role in sustaining global food production, but soils also provide essential support for many other ecosystem services, such as storing and filtering water, sequestering greenhouse gases, processing waste materials, and hosting complex microbial and terrestrial life.

Threats of soil degradation place an increased urgency to protect and replenish soils. Experts calculate a need for 70% more food production by 2050 in order to feed the growing global population. Without improved stewardship of soil resources, it will be impossible to meet this expanding demand.

Leading farmer, scientific, and government groups are rallying around the principle of "sustainable intensification". This concept calls for increasing food production from existing farmland using methods that present less pressure on the environment.

The principles of sustainable intensification arise from the acknowledgement that there is an urgent need to increase food production. However, this goal is best accomplished by achieving higher yields from existing land instead of increasing the area of land under cultivation. It is clear that true food security can only be accomplished by simultaneously achieving environmental sustainability. It is important to recognize that there is no single way to achieve sustainable intensification, since it must be adapted to local resources and conditions.

Table 1. Examples of factors commonly contributing to yield losses that hinder sustainable intensification (from Lobell et al., 2009).

Nutrient deficiency and imbalance	Water stress (drought and floods)
Weed competition	Insect damage
Plant disease	Inferior crop genetics
Improper planting	Soil limitations (such as salinity, acidity, compaction, etc.)

The concept of "Yield Gap" is used to measure the gulf between the most successful farmers (with minimal growth limitations) and the least productive farmers. There are numerous factors that account for yield gaps, but many opportunities exist to improve production by assisting lagging farmers to use their soil, water, and other resources more efficiently (**Table 1**). One recent global assessment of yield gaps found that nearly three quarters of underachieving areas could significantly close their current yield gaps by focusing on appropriate nutrient inputs (**Figure 1**).

Soil scientists and agronomists understand that a shortage of any one of the essential plant nutrients will be detrimental to crop growth and yield. With our advanced knowledge of plant nutrition, nutrient management, and the abundance of excellent fertilizer materials, it is imperative that this single largest cause of yield gaps be promptly addressed.

Comprehensive soil stewardship practices need to be widely implemented if the goals of sustainable intensification are to be met. Some of these practices include keeping the soil covered for as much of the year as possible, using a

Abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium.

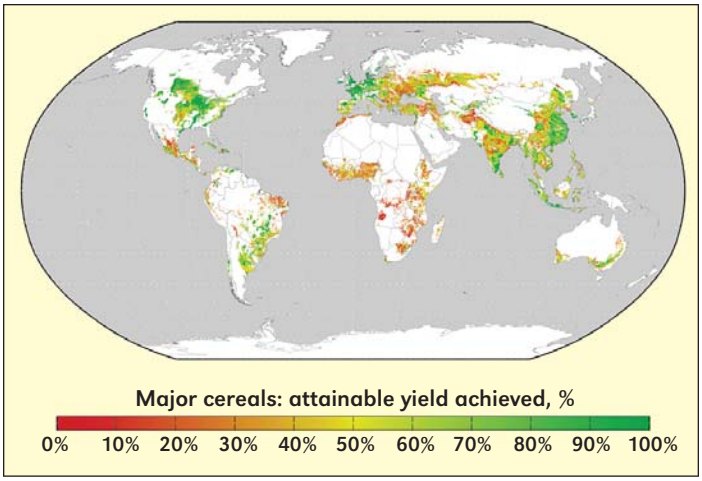


Figure 1. Average yield gaps for maize, wheat and rice. Measured as a percentage of the attainable yield achieved circa the year 2000. Yield gap in each grid cell is calculated as an area-weighted average across the crops and is displayed on the top 98% of growing area (from Mueller et al., 2012).

minimum amount of tillage, using appropriate crop rotations, implementing integrated nutrient management techniques, eliminating growth-limiting soil restrictions (such as acidity or salinity), and adopting erosion prevention and water conservation practices.

The challenge of producing sufficient food while decreasing the environmental impact of agriculture requires a careful reexamination of current practices. Using soil resources to their full potential and preserving vital soil functions demands multi-disciplinary engagement. Many of the tools needed to close existing yield gaps are already developed. The call to action is to now implement sustainable intensification so it benefits humanity in a global context. BC

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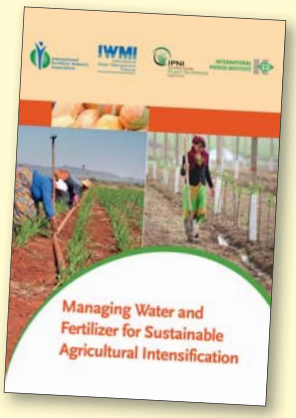
Mueller, N.D, J.S. Gerber, M. Johnston, D.K. Ray, N. Ramankutty, and J.A. Foley. 2012. Nature 490: 254–257 (11 October 2012) doi:10.1038/nature11420

NEW PUBLICATION

Managing Water and Fertilizer for Sustainable Agricultural Intensification



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This is a reference guide to improve general understanding of the best management practices for the use of water and fertilizers throughout the world to enhance crop production, improve farm profitability and resource efficiency, and reduce environmental impacts related to crop production.

For a hardcopy, please contact IPNI Circulation at circulation@ipni.net. A free pdf download of the book is available from IPNI at http://info.ipni.net/IPNI-3392.

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