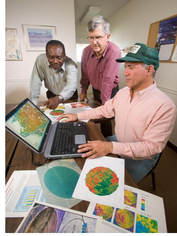
A New Nitrogen Index to Assess Sustainability of Cropping Systems of Andean Regions of South America



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Abstract

Population growth, impacts from a changing climate, and other challenges highlight the need to conserve soil and water quality so that maximization of crop yields to feed the expanding world population can be achieved and sustained into future generations. The Andean regions of South America are predominantly risky landscapes that have high slopes susceptible to erosion, especially after harvesting crops that leave low amounts of crop residue such as potatoes, and/or removing the straw from grain systems following cultivation of these landscapes. Tools that can be used by technical personnel who work with local farmers on these agricultural systems are needed to enhance communication with farmers and local communities in Andean regions and increase conservation. A new Nitrogen Index available in the English and Spanish languages, in metric and English units, and with a Soil Sustainability Index, was developed and evaluated for these regions by comparing results from the tool with research data. This Index is being used as an educational tool at the Universidad Estatal de Bolivar in Guaranda, Ecuador, and is helping its users assess the effects of management practices on the sustainability of cropping systems in their region. Preliminary results from evaluation of the new Nitrogen Index and its Soil Sustainability Index for these high-risk cropping system-landscape combinations of South America will be presented. These preliminary results suggest potential exists to use the tool to help assess effects of management practices on the sustainability of systems and on nitrogen use efficiencies in Andean regions of South America.

New 2012 Tool: Smartphone App

The Environmental Problem of Reactive Nitrogen Losses to the Environment: Nitrogen is one of the most important nutrients in agriculture; it is used worldwide as a fertilizer and it played an important role in the Green Revolution. The input of nitrogen to agricultural systems increases production and the viability of world farming operations. However, the use of nitrogen in agricultural systems can also allow it to escape at increased rates to the environment. Nitrogen losses from agricultural systems can average at about 30% of the applied N fertilizer. Managing nitrogen effectively continues to be a difficult and complicated endeavor. Improving nitrogen management (and by extension, nitrogen use efficiencies) is essential to reducing losses to the environment and protecting natural resources.

New Tools to Assess Nitrogen Management and Risk of Reactive Nitrogen Losses: The 2012 Nitrogen Index (4.4), which is written in the programming language Java™, and the new Nitrogen Index smartphone application, are new tools that can be used for assessing nitrogen management to increase nitrogen use efficiencies and reduce atmospheric, surface and leaching losses of nitrogen. These are new tools and concepts that are effective in helping users assess risk of nitrogen loss across landscape and cropping systems to conserve the environment and increase economic returns for farmers (e.g., monetary savings through reduced use of nitrogen fertilizer).

These New Technologies are Currently Being Used by Universities, NRCS, and Other National and International Users: The new California Nitrogen Index, Mexico Nitrogen Index, Caribbean Nitrogen Index, and South American Nitrogen Indexes can be run on a PC or even a smartphone (the smartphone application provides users the flexibility to run the Index right at the farm). These tools have already been transferred to U.S. federal agencies such as NRCS state offices. Additionally, these prototypes have been transferred to users from universities and national and international research centers. The tools were also developed in cooperation with Foreign Agricultural Service (FAS) and USAID programs as well as national and international universities, and have been transferred to users in Bolivia, Ecuador, and Mexico, among other locations. The Nitrogen Index can be downloaded from http://www.ars.usda.gov/npa/spnr/nitrogentools. ***The smartphone application for the Nitrogen Index is available at*** https://market.android.com/details?id=gov.usda.ars.spnr.driver#?t=W251bGwsMSwxLDIxMiwiZ292LnVzZGEuYXJzLnNwbnIuZHJpdmVyIl0.

Figure 1. Impacts of erosion in cultivated fields of the Illangama watershed located at an altitude of 3,400 m. As can be seen in the photo, a lack of conservation practices has contributed to higher erosion rates and to the loss of the more productive soil surface horizon, exposing a less fertile subsoil below.

Figure 2. Dr. Jorge A. Delgado, Soil Scientist (USDA-ARS) and Carlos Monar, Agricultural Engineer (Universidad Estatal de Bolivar) visited with farmers during a day at the field about the importance of conservation practices and soil quality. The field day was conducted at the Illangama watershed.

Figure 3. Example of use of grass buffers in combination with water collection ditches across the slope as a key soil and water conservation practice in the USAID studies conducted at the Matias Paguay farm located in the Illangama watershed at 3400 m above sea level.

Figure 4. Interview with Dr. Jorge A. Delgado for the Channel 5 Program, TV Cultural Municipal Guaranda, with TV reporter Lcdo. Angel García. Dr. Delgado was interviewed about the potential to improve nitrogen management and conservation practices for agricultural sustainability in Ecuador. The program aired August 19th, 2011 from 5:00-6:00 pm local time on Channel 5 in Guaranda, Ecuador.

Figure 5. Dr. Delgado conducting a one-day training in the use of the Ecuador Nitrogen Index with a Sustainability Index. Training attendees included individuals from the USAID project, INIAP, and Universidad Estatal de Bolivar. Participants of the training brought their own laptop computers. Using their laptops they were able to download the Nitrogen Trading Tool from the USDA-ARS server located in Fort Collins, Colorado, and the students were able to participate in the training.

Figure 6. Dr. Delgado (USDA-ARS) training and working with Universidad Estatal de Bolivar student Rosa Arevalo, who is being sponsored in the USAID project. Data from studies being conducted at the Alumbre watershed were entered into Nitrogen Index files to conduct calibration and validation of the Ecuador Nitrogen Index tool.

Figure 7. Harvesting potato varieties in an Andean field site at low altitude (area of Tiraque, near the site of Cochabamba, Bolivia).

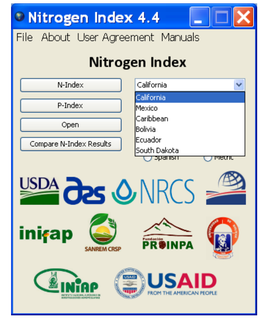

Figure 8. Nitrogen Index 4.4 (2012 version; written in the programming language Java™) is available in the English and Spanish languages.

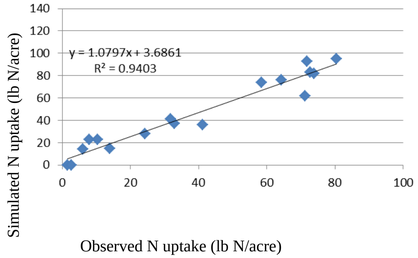

Figure 9. Uptake simulated by the Nitrogen Index versus observed uptake (Bolivian cropping systems).

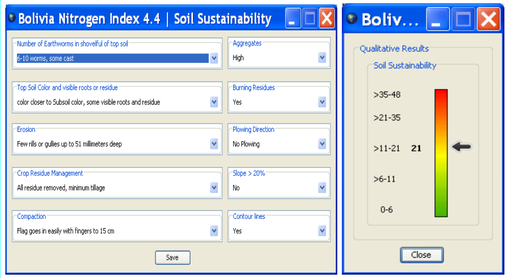

Figure 10. Sustainability Index for South American cropping systems.

Summary

Many scientific advances of the last two decades are contributing to the development of viable management practices that can reduce nitrogen losses to the environment. Yet, there are still significant nitrogen losses, with average nitrogen use efficiencies of around 30 to 40% still being reported. The nitrogen indexes for Bolivia and Ecuador are a new method for evaluating nitrogen management in this region. Nutrient managers can use these new tools when assessing management practices to help them make decisions that can contribute to increased nitrogen use efficiencies and reduced losses of reactive nitrogen to the environment.

Preliminary results suggest that there is potential to use these new technologies and conservation practices to promote sustainability in the Andean region of South America. These results show that there is also potential to use this tool to help increase nitrogen use efficiencies for these Andean cropping systems. The tool is being used by professors and students to assist in the transfer of scientific information, and by agronomists and conservationists to improve conservation in the field.

The testing and development of this tool was supported in part by a USAID-SANREM-Virginia Polytechnic Institute and State University project. This project is having an ongoing impact and showcases the positive results of soil and water conservation. This project is contributing to the training of farmers and the implementation of rotations and conservation practices that reduce the risk of erosion and potentially increase economic returns for farmers.

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**** For additional information, a complete list of references, questions, reprints, or requests for new tools, please email Dr. Jorge A. Delgado at: jorge.delgado@ars.usda.gov.***