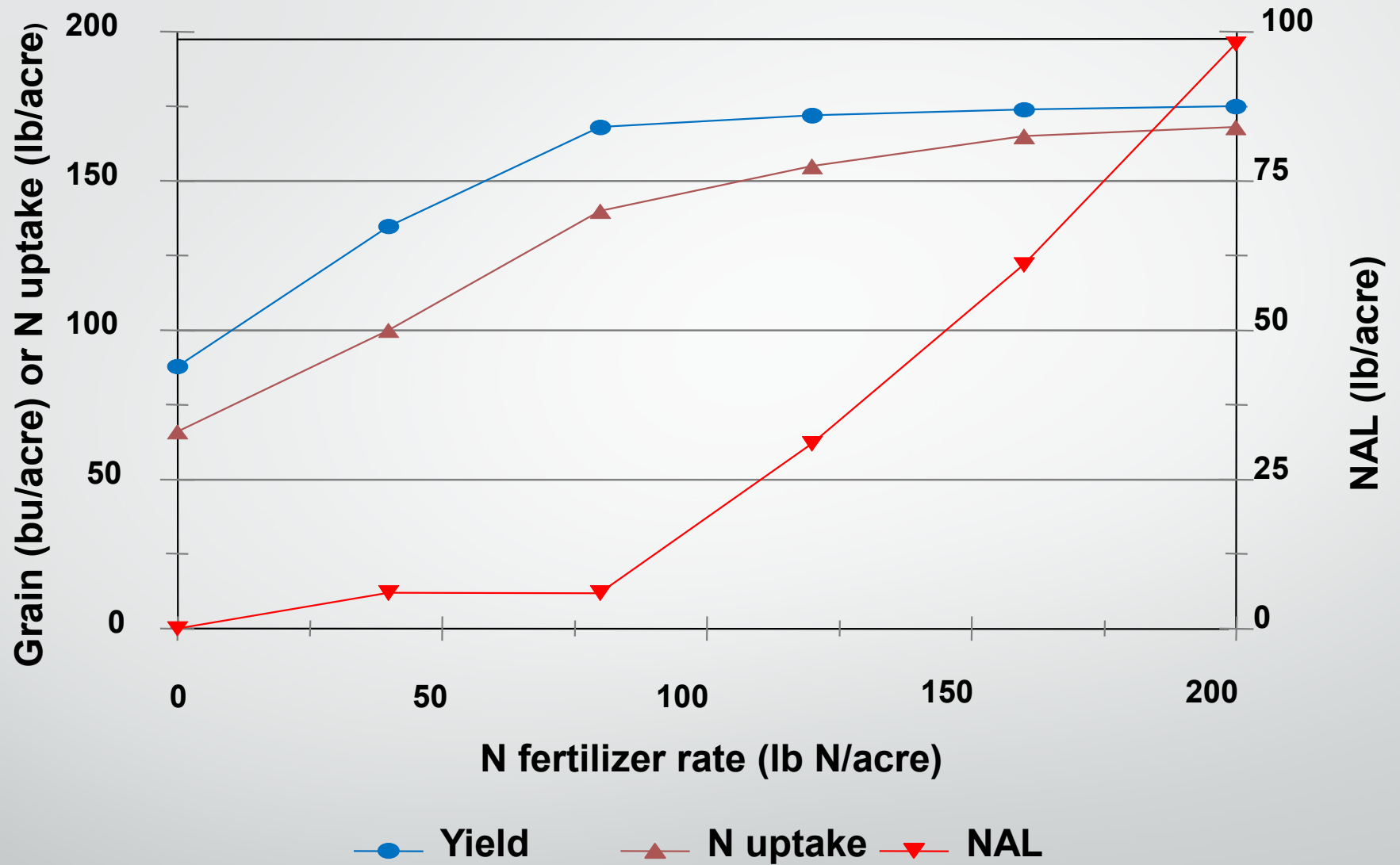




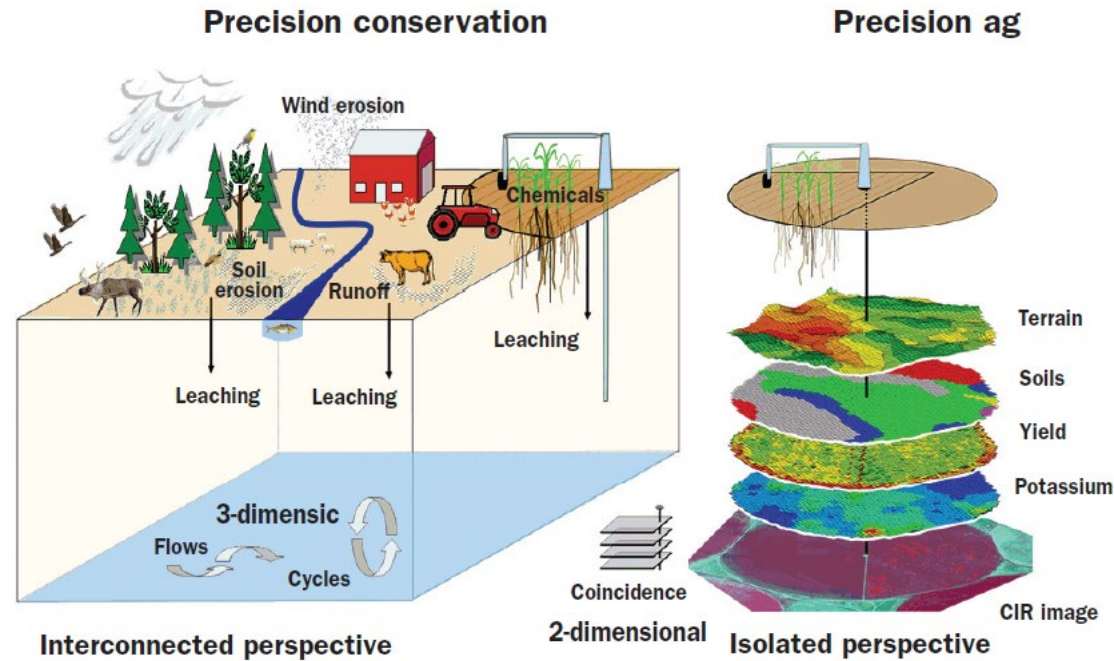


# Nitrogen Management

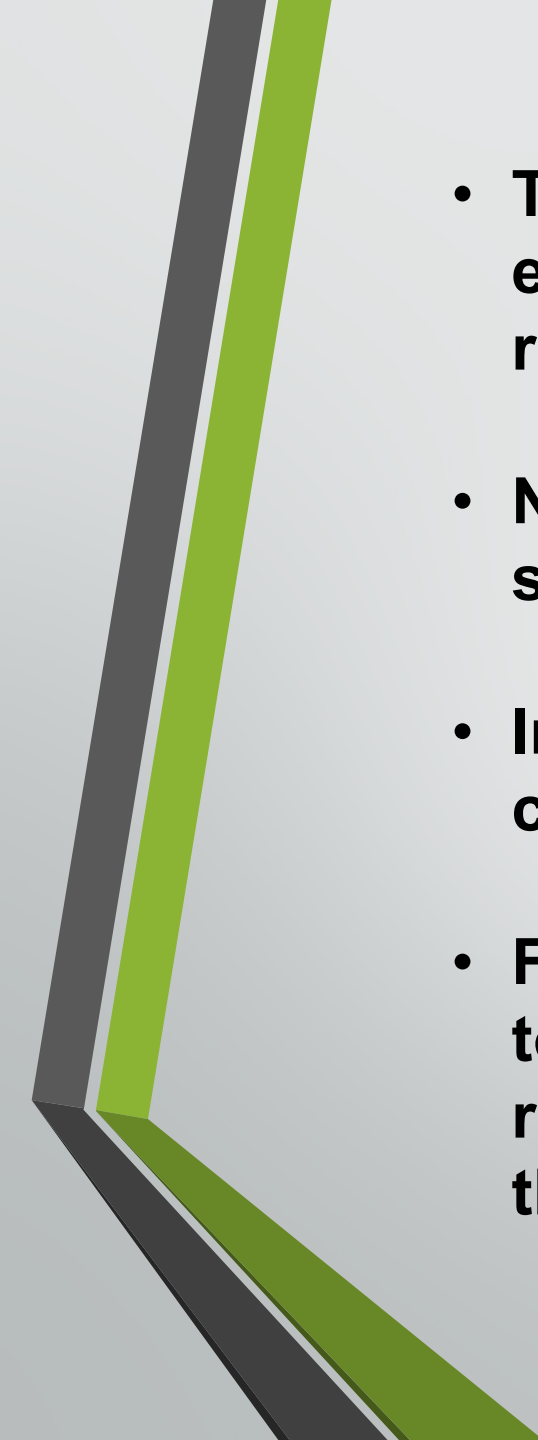


**Figure 13.** Effect of N fertilizer rate applications on yield and N uptake by irrigated corn (Adapted from Bock and Hergert, 1991). Potential N available to leach (NAL) assuming major pathway for losses is leaching. The NAL was estimated as  $NAL = N \text{ applied} - N \text{ uptake}$ .

# Nitrogen Management of Agricultural Systems

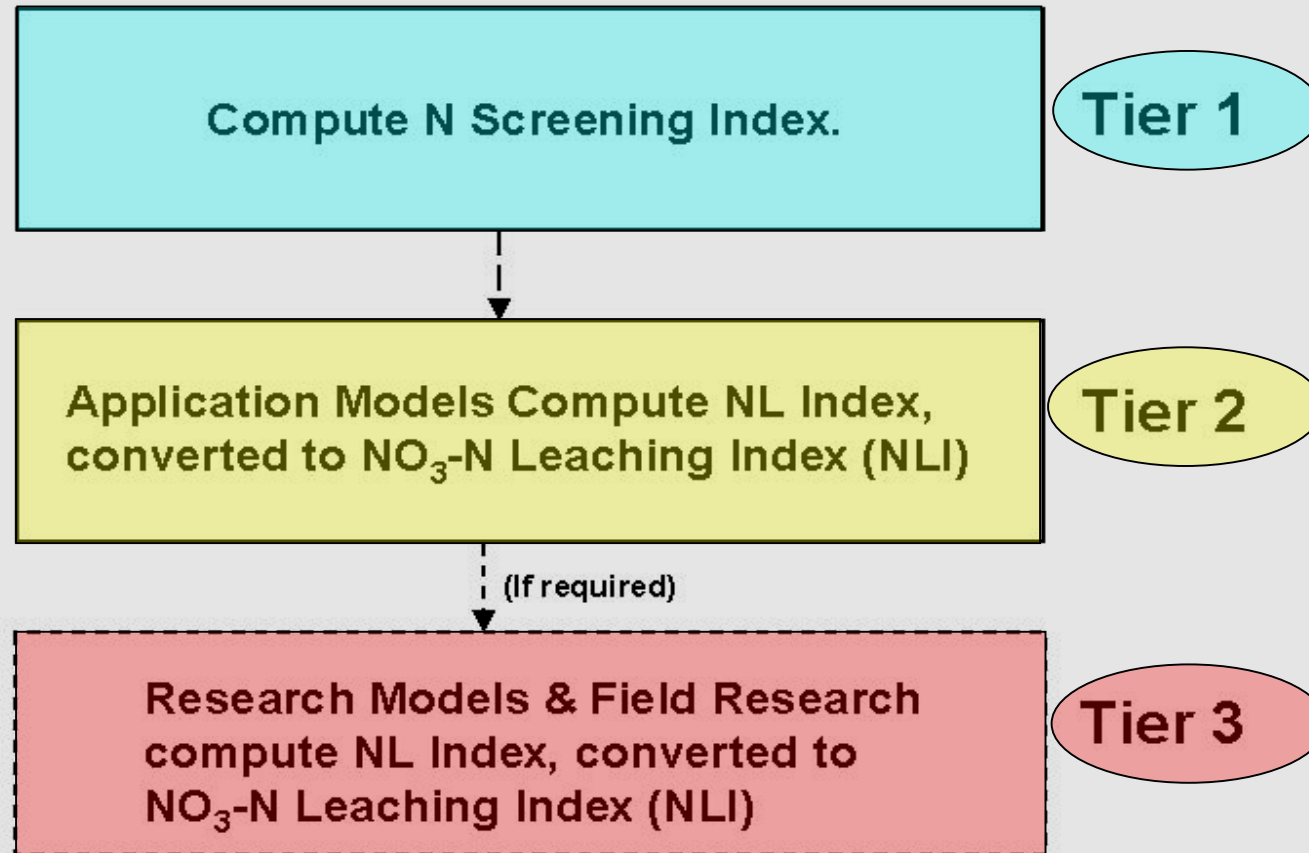


How do we precisely manage nitrogen to increase its efficiency and reduce its losses to the environment?

- 
- **There are countless nutrient/nitrogen management tools in existence, ranging from simple Tier-1 tools to highly complex research models (Tier-3).**
  - **Nitrogen is the most critical nutrient used in cropping systems worldwide.**
  - **In the majority of soil systems where nitrogen is applied, crops respond with higher yields.**
  - **Following are just two examples of nitrogen management tools that could be used to help improve fertilizer recommendations while reducing reactive nitrogen losses to the environment.**



# Nitrogen Index



**Figure 6.** Tier structure of proposed NO<sub>3</sub>-N leaching index (NLI) (From Shaffer and Delgado, 2002).

Shaffer, M., and J.A. Delgado. 2002. Essentials of a national nitrate leaching index assessment tool. *Journal of Soil and Water Conservation* 57(6):327-335.

# Nitrogen Index

N-Index

P-Index

Open

Compare N-Index Results

- California
- California
- Kentucky
- South Dakota
- Mexico
- Caribbean
- Bolivia
- Ecuador

Portuguese





International Soil and Water Conservation Research 5 (2017) 69–75

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International Soil and Water Conservation Research

journal homepage: [www.elsevier.com/locate/iswcr](http://www.elsevier.com/locate/iswcr)

Original Research Article

The new Caribbean Nitrogen Index to assess nitrogen dynamics in vegetable production systems in southwestern Puerto Rico<sup>✉</sup>

Miguel Oliveras-Bercoales<sup>a</sup>, David Sotomayor-Ramírez<sup>b</sup>, Jorge A. Delgado<sup>c,\*</sup>, Luis R. Pérez-Alegria<sup>d</sup>

<sup>a</sup> USDA-NRCS, Arkansas: 2600 Federal Building, 100 E. 8th Ave, Pine Bluff, AR 71601, USA  
<sup>b</sup> University of Puerto Rico, Mayagüez Campus, College of Agricultural Sciences, Department of Agroenvironmental Sciences, PO Box 9000, Mayagüez, PR 00680, USA  
<sup>c</sup> USDA-ARS, Acting Research Leader, Soil Management and Sugar Beet Research Unit, 2150 Centre Ave., Building D, Suite 100, Fort Collins, CO 80526, USA  
<sup>d</sup> University of Puerto Rico, Mayagüez Campus, College of Agricultural Sciences, Department of Agricultural and Biosystems Engineering, USA

International Soil and Water Conservation Research 4 (2016) 1–5

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International Soil and Water Conservation Research

journal homepage: [www.elsevier.com/locate/iswcr](http://www.elsevier.com/locate/iswcr)

Original Research Article


A nitrogen index for improving nutrient management within commercial Mexican dairy operations

Uriel Figueroa-Viramontes<sup>a</sup>, Jorge A. Delgado<sup>b,\*</sup>, Juan I. Sánchez-Duarte<sup>a</sup>, Esmeralda Ochoa-Martínez<sup>a</sup>, Gregorio Núñez-Hernández<sup>a</sup>

<sup>a</sup> INIFAP, Campo Experimental La Laguna, Boulevard José Santos Valdez #1200 Pte., Col. Centro, Matamoros CP. 27440, Matamoros Coahuila, Mexico  
<sup>b</sup> USDA-ARS, 2150 Centre Avenue, Building D, Fort Collins, CO 80526, United States



Ecological Engineering 73 (2014) 778–785

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Ecological Engineering

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Use of the new Nitrogen Index *tier zero* to assess the effects of nitrogen fertilizer on N<sub>2</sub>O emissions from cropping systems in Mexico

Vinisa Saynes<sup>b</sup>, Jorge A. Delgado<sup>a,\*</sup>, Caleb Tebbe<sup>a</sup>, Jorge D. Etchevers<sup>b</sup>, Daniel Lapidus<sup>c</sup>, Adriana Otero-Armaiz<sup>c</sup>

<sup>a</sup> USDA-ARS, Soil Plant Nutrient Research Unit, 2150 Centre Avenue, Building D, Fort Collins, CO 80526, United States  
<sup>b</sup> Colegio de Postgraduados, Laboratorio de Fertilidad de Suelos y Química Ambiental, Texcoco, Mexico  
<sup>c</sup> USDA-FAS, 1400 Independence Avenue, SW, Washington, D.C. 20250, United States



TECHNICAL ARTICLE





A New Nitrogen Index for Assessment of Nitrogen Management of Andean Mountain Cropping Systems of Ecuador

Luis Escudero,<sup>1</sup> Jorge A. Delgado,<sup>2</sup> Carlos Monar,<sup>3</sup> Franklin Valverde,<sup>1</sup> Víctor Barrera,<sup>1</sup> and Jeffrey Alwang<sup>2</sup>

**Abstract:** Corn (*Zea mays* L.) is important for food security in much of Ecuador. Small-scale farmers are using nitrogen (N) fertilizer without technical advice based on soil, crop, and climatologic data. The literature lacks studies where tools that can quickly assess management practices' ef-

2012). Technologies such as conservation agriculture, conservation practices to aid adaptation to climate change, and improved policies related to increasing agricultural productivity while conserving the land may help break the cycle of poverty (Delgado et al., 2011a; Alwang et al., 2013).

Journal of Hydrology 365 (2009) 183–194

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Journal of Hydrology

journal homepage: [www.elsevier.com/locate/jhydrol](http://www.elsevier.com/locate/jhydrol)

Use of a new GIS nitrogen index assessment tool for evaluation of nitrate leaching across a Mediterranean region

José M. De Paz<sup>a,1</sup>, Jorge A. Delgado<sup>b,\*</sup>, Carlos Ramos<sup>a,2</sup>, Marvin J. Shaffer<sup>c</sup>, Kenneth K. Barbarick<sup>d</sup>

<sup>a</sup> Centro para el Desarrollo de la Agricultura Sostenible, Instituto Valenciano de Investigaciones Agrarias, Carretera Moncada-Náquera km 4.5, Apdo. Oficial 46113 Moncada, Valencia, Spain  
<sup>b</sup> USDA-ARS, Soil and Plant Nutrient Research Unit, 2150 Centre Avenue, Building D, Suite 100, Fort Collins, CO 80526, USA  
<sup>c</sup> USDA-ARS (retired), Loveland, CO 80538, USA  
<sup>d</sup> Soils and Crops Department, Colorado State University, Fort Collins, CO 80523, USA

ECOLOGICAL ENGINEERING 32 (2008) 108–120

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An index approach to assess nitrogen losses to the environment<sup>✉</sup>

J.A. Delgado<sup>a,\*</sup>, M. Shaffer<sup>b</sup>, C. Hu<sup>c</sup>, R. Lavado<sup>d</sup>, J. Cueto-Wong<sup>e</sup>, P. Joosse<sup>f</sup>, D. Sotomayor<sup>g</sup>, W. Colon<sup>h</sup>, R. Follett<sup>a</sup>, S. DelGrosso<sup>a</sup>, X. Li<sup>c</sup>, H. Rimski-Korsakov<sup>d</sup>

<sup>a</sup> Soil Plant Nutrient Research Unit, USDA, Agricultural Research Service, 2150 Centre Avenue, Building D, Suite 100, Fort Collins, CO 80526, United States  
<sup>b</sup> Shaffer Consulting, Loveland, CO 80538, United States

International Soil and Water Conservation Research 4 (2016) 237–244

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International Soil and Water Conservation Research

journal homepage: [www.elsevier.com/locate/iswcr](http://www.elsevier.com/locate/iswcr)

Original Research Article

Use of the Nitrogen Index to assess nitrate leaching and water drainage from plastic-mulched horticultural cropping systems of Florida<sup>✉</sup>

Edilene C.S. Marchi<sup>a,b,d</sup>, Lincoln Zotarelli<sup>b</sup>, Jorge A. Delgado<sup>c,\*</sup>, Diane L. Rowland<sup>d</sup>, Giuliano Marchi<sup>e</sup>

<sup>a</sup> Instituto Federal de Educação, Ciência e Tecnologia de Brasília, Campus Planaltina, DF, Rodovia DF-128 - 21 - Zona Rural de Planaltina, Brasília-DF 72380-900, Brazil  
<sup>b</sup> University of Florida - Horticultural Science Department, 1241 Hfield Hall, Gainesville, FL 32611, USA  
<sup>c</sup> USDA-ARS, Soil Management and Sugar Beet Research Unit, 2150 Centre Ave., Building D, Suite 100, Fort Collins, CO 80526, USA



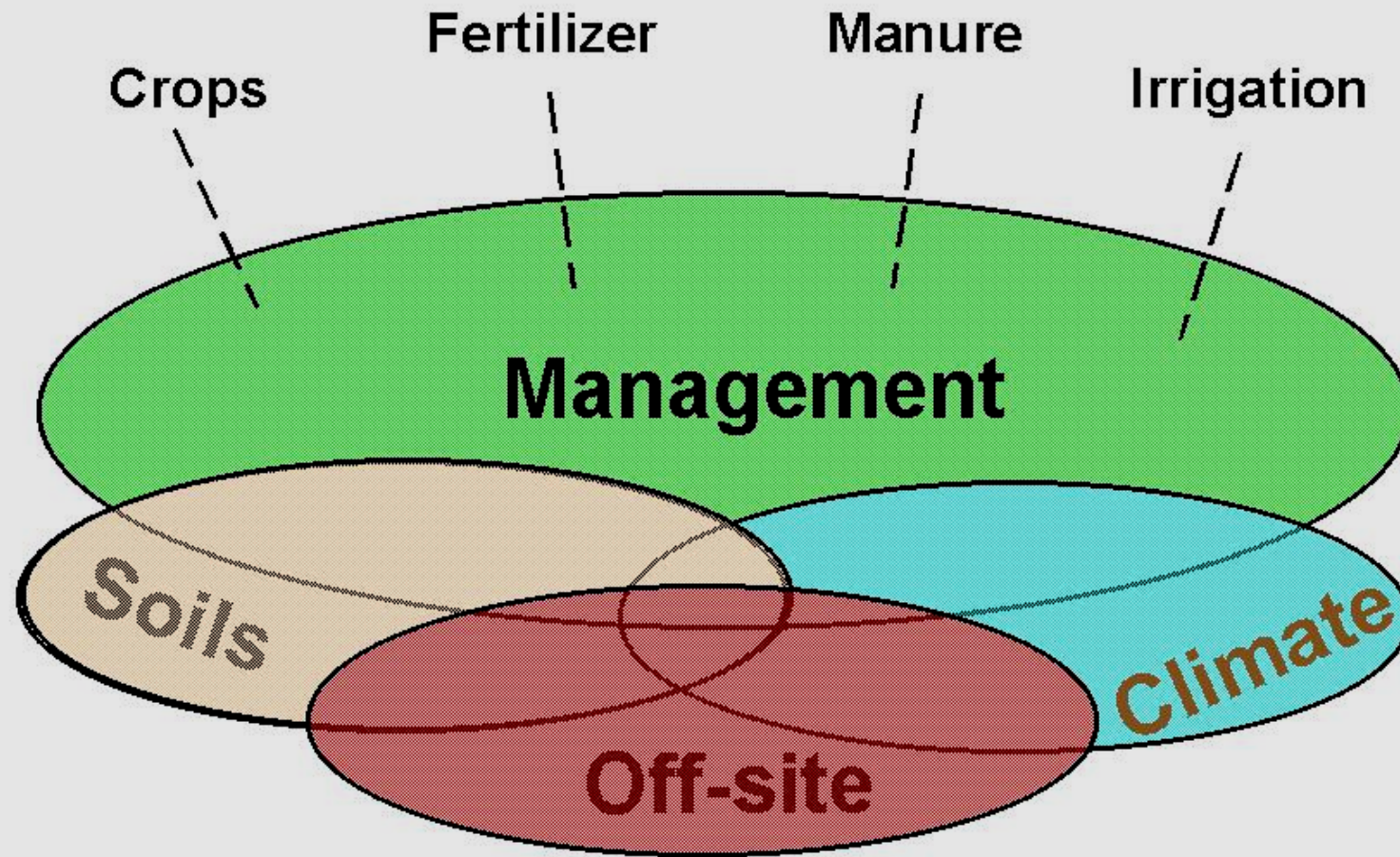
A NEW N INDEX TO ASSESS NITROGEN DYNAMICS IN POTATO (*Solanum tuberosum* L.) PRODUCTION SYSTEMS OF BOLIVIA

UN NUEVO ÍNDICE DE NITRÓGENO PARA EVALUAR LA DINÁMICA DE NITRÓGENO EN SISTEMAS DE PRODUCCIÓN DE PAPA (*Solanum tuberosum* L.) EN BOLIVIA

Ana K. Saavedra<sup>1</sup>, Jorge A. Delgado<sup>2,\*</sup>, Ruben Botello<sup>1</sup>, Pablo Mamani<sup>1</sup>, Jeffrey Alwang<sup>3</sup>

<sup>1</sup>PROINPA, Cochabamba, Bolivia. <sup>2</sup>USDA-ARS, Soil Plant Nutrient Research Unit, Fort Collins, CO 80526. (Jorge.Delgado@ars.usda.gov). <sup>3</sup>Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

ABSTRACT ABSTRACT



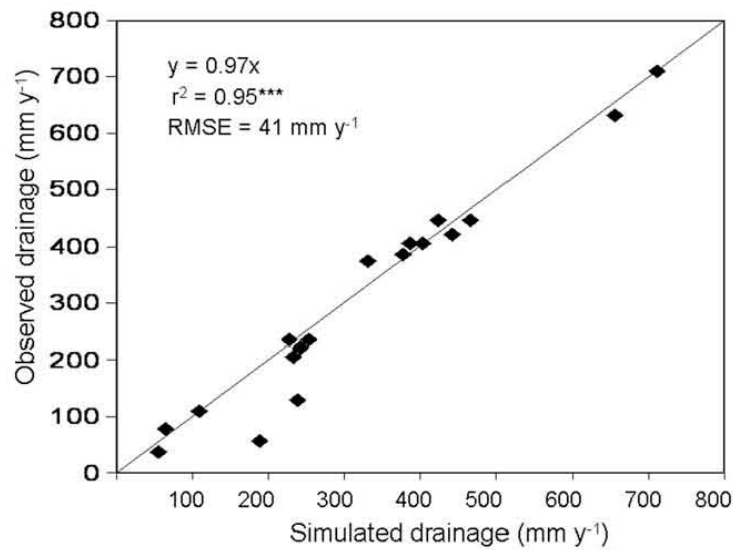
**Figure 5.** Essential components of NO<sub>3</sub>-N leaching index (NLI) (From Shaffer and Delgado, 2002).

Shaffer, M., and J.A. Delgado. 2002. Essentials of a national nitrate leaching index assessment tool. *Journal of Soil and Water Conservation* 57(6):327-335.

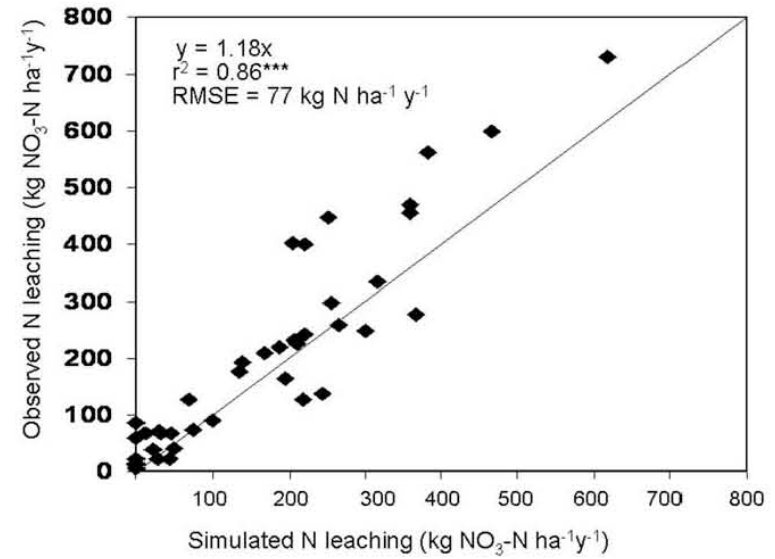


# **Team Efforts Across Nations: Case Scenarios**

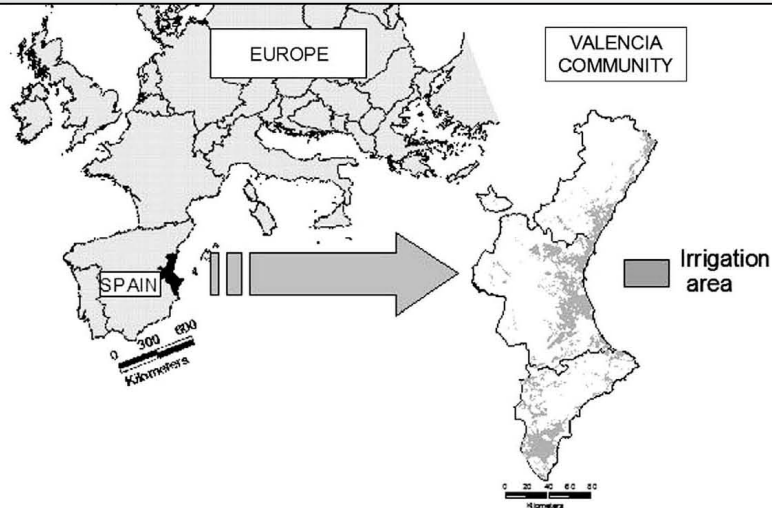
***Mediterranean Region of Spain  
&  
Pampas Region of Argentina***



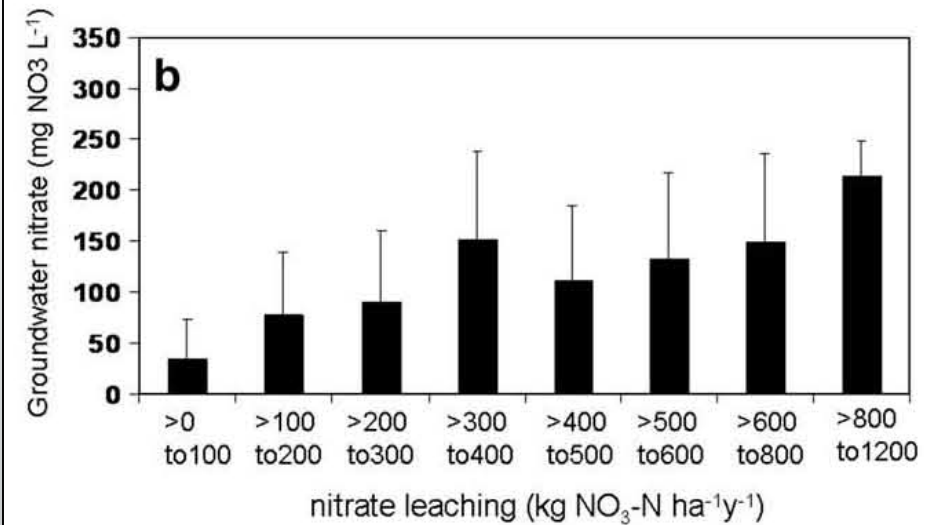
**Figure 3.** Calibration of observed vs. simulated drainage with the GIS nitrogen index tier one (GIS NIT-1) tool.



**Figure 5.** Calibration of observed vs. simulated nitrate leaching with the GIS nitrogen index tier one (GIS NIT-1) tool.



**Figure 1.** Study area location.




From: De Paz, J.M., J.A. Delgado, C. Ramos, M. J. Shaffer, K.K. Barbarick. 2009. Use of a new GIS nitrogen index assessment tool for evaluation of nitrate leaching across a Mediterranean region. *Journal of Hydrology* 365:183–194.



# **Team Efforts Across Nations: Case Scenarios**

***Mexico***

**MÉXICO 2010**




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**Reporte Anual 2009**  
Ciencia y Tecnología para el Campo Mexicano

INSTITUTO NACIONAL DE INVESTIGACIONES FORESTALES, AGRÍCOLAS Y PECUARIAS  
Oficinas Centrales México, D. F. Abril de 2010  
Publicación Especial Núm. 5 ISBN 978-607-425-316-0

**25 Aniversario**  
Ciencia y Tecnología para el Campo Mexicano



Vivir Mejor

- Índice de nitrógeno para la producción de cultivos forrajeros para estimar pérdidas de nitrógeno al ambiente para los sistemas de producción de leche intensivo y familiar.

Redes de Investigación e Innovación

positivamente en el crecimiento, la producción láctea y la reproducción de hembras bovinas lecheras y de doble propósito; mejoramiento genético para incrementar la productividad, calidad de leche y longevidad; mitigación del estrés calórico en el ganado; rehabilitación y manejo de tierras de pastores; producción sustentable de forrajes cultivados; información económica para toma de decisiones y estrategia integral de transferencia de tecnología.

**Logros**

- Destacan para el sistema de doble propósito en el Tópico Húmedo, la mayor producción (más de 25%) de los pastos Mombasa (*Panicum maximum*) cv Mombasa y Chetumal (*Brachiaria humidicola*), en comparación al pasto Estrella de África y el aumento a través de modelos de simulación en la producción de leche de más de 2 litros/vaca/día e incluso superiores durante la época seca con el uso de leucaena en praderas tropicales.
- En el sistema intensivo con un patrón de cultivos forrajeros alternativos a la alfalfa constituido por canola (*Brassica napus* L.), maíz (*Zea mays* L.) y soya (*Glycine max* L. Merr.) se obtuvieron rendimientos de proteína cruda similares a la alfalfa, pero con mayores rendimientos de materia seca (64%) y energía neta de lactancia (77%), así como incrementos de 60 y 77% en los valores de eficiencia en el uso de agua en producción de materia seca y energía neta de lactancia por m<sup>3</sup> de agua.
- Con las evaluaciones genéticas de toros Holstein se continuó la identificación de sementales sobresalientes con habilidad predictiva de transmisión de 1,500 kg de leche. Los estudios de balance de nitrógeno indican que del total de nitrógeno excretado en las cuencas lecheras se aprovecha de 20 a 70% como fertilizante en cultivos forrajeros. Las pérdidas de nitrógeno al ambiente constituyen

Manuales de producción de leche de bovino para los sistemas de lechería especializado, familiar y doble propósito en los cuales se presentan los conocimientos y tecnologías disponibles, así como un enfoque de procesos para su aplicación en las unidades de producción.



- Índice de nitrógeno para la producción de cultivos forrajeros para estimar pérdidas de nitrógeno al ambiente para los sistemas de producción de leche intensivo y familiar.

25 Aniversario  
Ciencia y Tecnología para el Campo Mexicano

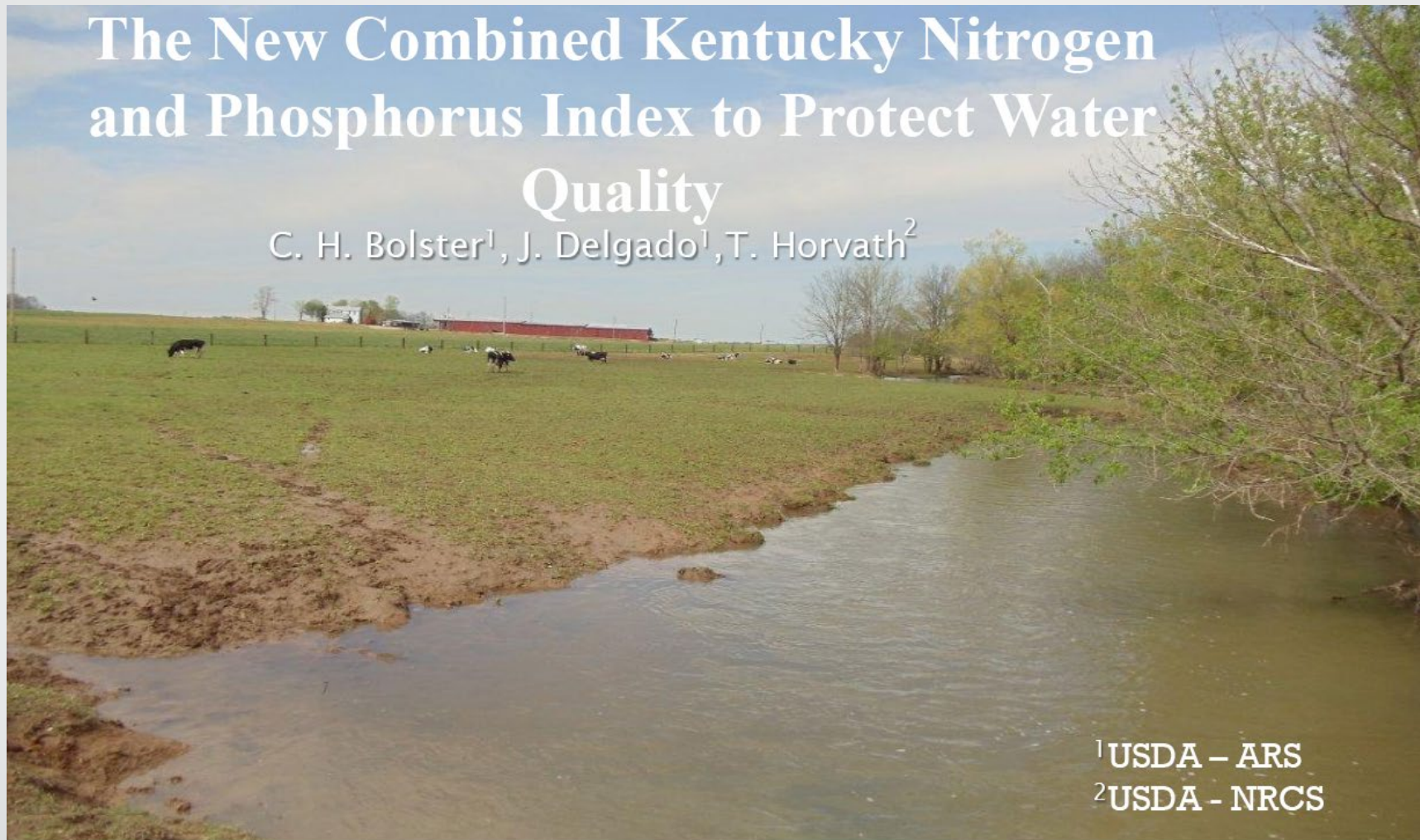
31



**Team Efforts Across Nations:  
Case Scenarios  
*Kentucky, USA***

# The New Combined Kentucky Nitrogen and Phosphorus Index to Protect Water Quality

C. H. Bolster<sup>1</sup>, J. Delgado<sup>1</sup>, T. Horvath<sup>2</sup>



<sup>1</sup>USDA – ARS  
<sup>2</sup>USDA – NRCS

*Kentucky Water Resources Annual Symposium  
Lexington, KY - March 18, 2013*



**Presented by: Tibor Horvath USDA - NRCS**

Bolster, C.H., T. Horvath, B.D. Lee, S. Mehlhope, S. Higgins, and J.A. Delgado. 2014. Development and testing of a new phosphorus index for Kentucky. *Journal of Soil and Water Conservation* 69(3):183-196.



“NRCS in Kentucky, in partnership with the [Agricultural Research Service \(ARS\)](#), developed a new combined Nitrogen and Phosphorus Risk Assessment Tool to protect water quality and analyze the potential impacts to the Kentucky livestock industry. The tool is the first in the nation to generate two risk assessment reports – one for Nitrogen and one for Phosphorus - with one single data input to reduce the time spent on conservation planning.”

The screenshot shows the USDA Natural Resources Conservation Service Kentucky website. The header includes the USDA logo, the text 'Natural Resources Conservation Service Kentucky', and the 'United States Department of Agriculture'. Navigation links for 'About Us', 'National Centers', and 'State Websites' are present. A search bar and a 'Help' link are also visible. Below the header, there are tabs for 'Topics', 'Programs', 'Newsroom', and 'Contact Us'. A breadcrumb trail reads 'You are Here: Home / Technical Resources / Ecological Science / Nutrient Management'. A 'Stay Connected' section features social media icons for Facebook, Twitter, YouTube, Email, and RSS. The main content area is divided into two columns. The left column, titled 'Technical Resources', contains a list of categories: Conservation Planning, Data, Maps, & Analysis, Ecological Science (with sub-items: Agronomy, Biology, Cultural Resources, Invasive Species, Manure Management, Nutrient Management, Pest Management, Threatened & Endangered Species), Engineering, Land Use, and State Technical Committee. The right column, titled 'Nutrient Management', features an email sign-up box with the text 'Get E-MAIL updates from govDELIVERY. Sign up for email updates related to Nutrient Management in Kentucky'. Below this, a paragraph explains that nutrients are building blocks for plant growth and production. A second paragraph states that NRCS in Kentucky, in partnership with the Agricultural Research Service (ARS), developed a new combined Nitrogen and Phosphorus Risk Assessment Tool. A 'Reference Documents' section follows, listing a policy document from the United States Department of Agriculture and a link to the NRCS Nutrient Management Website. At the bottom, there are links for 'Manure & Nutrient Management | NRCS (usda.gov)' and 'Comprehensive Nutrient Management Plans'.

Excerpt and screenshot from USDA-NRCS webpage:

USDA-NRCS. 2022. Nutrient Management. Accessed 22 July 2022:

<https://www.nrcs.usda.gov/wps/portal/nrcs/main/ky/technical/ecoscience/nutrient/>

“The NRCS is using a Nitrogen Index Tool that can assess the risk of Nitrate leaching based on the field’s soil type, the crops grown, and the fertilizer materials used, and can be utilized to choose different crops or nutrient sources to alleviate the Nitrate leaching rate to the ground water.”

The screenshot shows the USDA Natural Resources Conservation Service Kentucky website. The header includes the USDA logo, the text 'Natural Resources Conservation Service Kentucky', and the 'United States Department of Agriculture'. Navigation links for 'About Us', 'National Centers', and 'State Websites' are present. A search bar and a 'Browse By Audience' dropdown are also visible. The main content area is titled 'Nutrient Management - Field Application' and features a sidebar with 'Technical Resources' such as 'Conservation Planning', 'Data, Maps, & Analysis', 'Ecological Science', 'Agronomy', 'Biology', 'Cultural Resources', 'Invasive Species', 'Manure Management', 'Nutrient Management', 'Pest Management', 'Threatened & Endangered Species', 'Engineering', 'Land Use', and 'State Technical Committee'. The main article is titled 'Cooperative effort to protect Kentucky’s water resources from nutrient and pathogen pollution originating from manure and fertilizer applications' by Tibor Horvath, Nutrient Management Specialist for NRCS in Kentucky. The article text states: 'The USDA Natural Resources Conservation Service (NRCS) along with the Kentucky Division of Conservation and the University of Kentucky Cooperative Extension Service is helping Kentucky growers develop and implement a Nutrient Management Plan that can greatly reduce the nutrient runoff and leaching to surface and ground water from field applications of animal manure and fertilizers and the same time improve the farm’s profitability.' Below the article, there are sections titled 'What is the Kentucky Agriculture Water Quality Act?' and 'Whom does the Kentucky Agriculture Water Quality Act affect?'. The 'What is the Kentucky Agriculture Water Quality Act?' section states: 'The Kentucky General Assembly passed the Kentucky Agriculture Water Quality Act in 1994 (KRS. 224.71-100 through 224.71-140). The goal of the act is to protect surface and groundwater resources from pollution as a result of agriculture and silviculture (forestry) activities.' The 'Whom does the Kentucky Agriculture Water Quality Act affect?' section states: 'The Agriculture Water Quality Act requires all landowners with 10 or more acres used for agriculture or silviculture operations to develop and implement a water quality plan based on guidance from the Kentucky Agriculture Water Quality Plan. It is the sole responsibility of each landowner to develop, implement and revise when needed, a water quality plan for their individual operations.'

Excerpt and screenshot from USDA-NRCS webpage:

USDA-NRCS. 2022. Nutrient Management – Field Application. Accessed 22 July 2022:

<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ky/technical/ecoscience/nutrient/?cid=stelprdb1257173>



# **Team Efforts Across Nations: Case Scenarios**

***China***



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# Agriculture, Ecosystems and Environment

journal homepage: [www.elsevier.com/locate/agee](http://www.elsevier.com/locate/agee)



## Regional simulation of nitrate leaching potential from winter wheat-summer maize rotation croplands on the North China Plain using the NLEAP-GIS model

Zhuoting Li<sup>a,b,c</sup>, Xiumei Wen<sup>b</sup>, Chunsheng Hu<sup>a,\*</sup>, Xiaoxin Li<sup>a</sup>, Shanshan Li<sup>b</sup>, Xiaosen Zhang<sup>b</sup>, Baoqing Hu<sup>b,c</sup>

<sup>a</sup> Key Laboratory of Agricultural Water Resources, Center for Agricultural Resources Research, Institute of Genetic and Developmental Biology, The Chinese Academy of Sciences, 286 Huaizhong Road, Shijiazhuang 050021, China

<sup>b</sup> Key Laboratory of Environment Change and Resources Use in Beibu Gulf, Ministry of Education, Nanning Normal University, 175 East Mingxiu Road, Nanning 530001, China

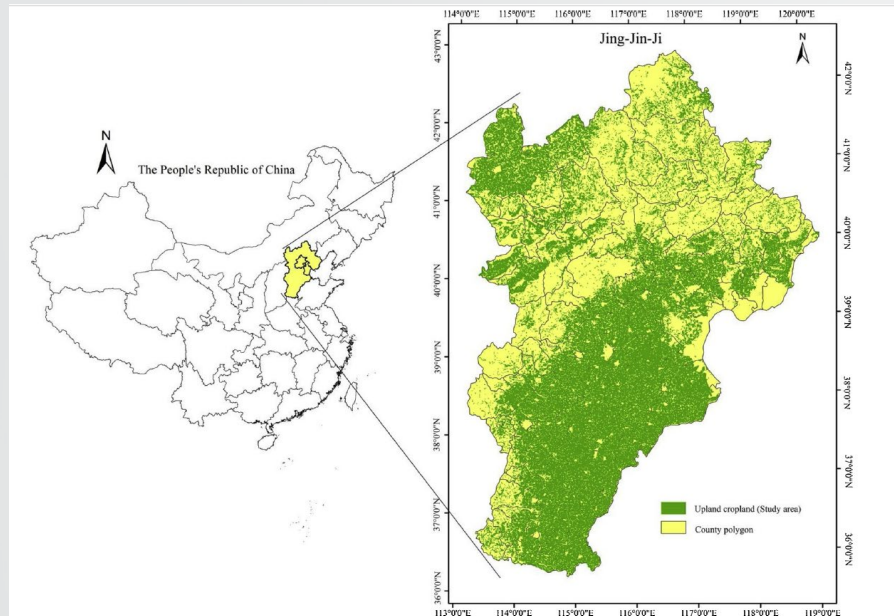
<sup>c</sup> Guangxi Key Laboratory of Earth Surface Processes and Intelligent Simulation, Nanning Normal University, 175 East Mingxiu Road, Nanning 530001, China



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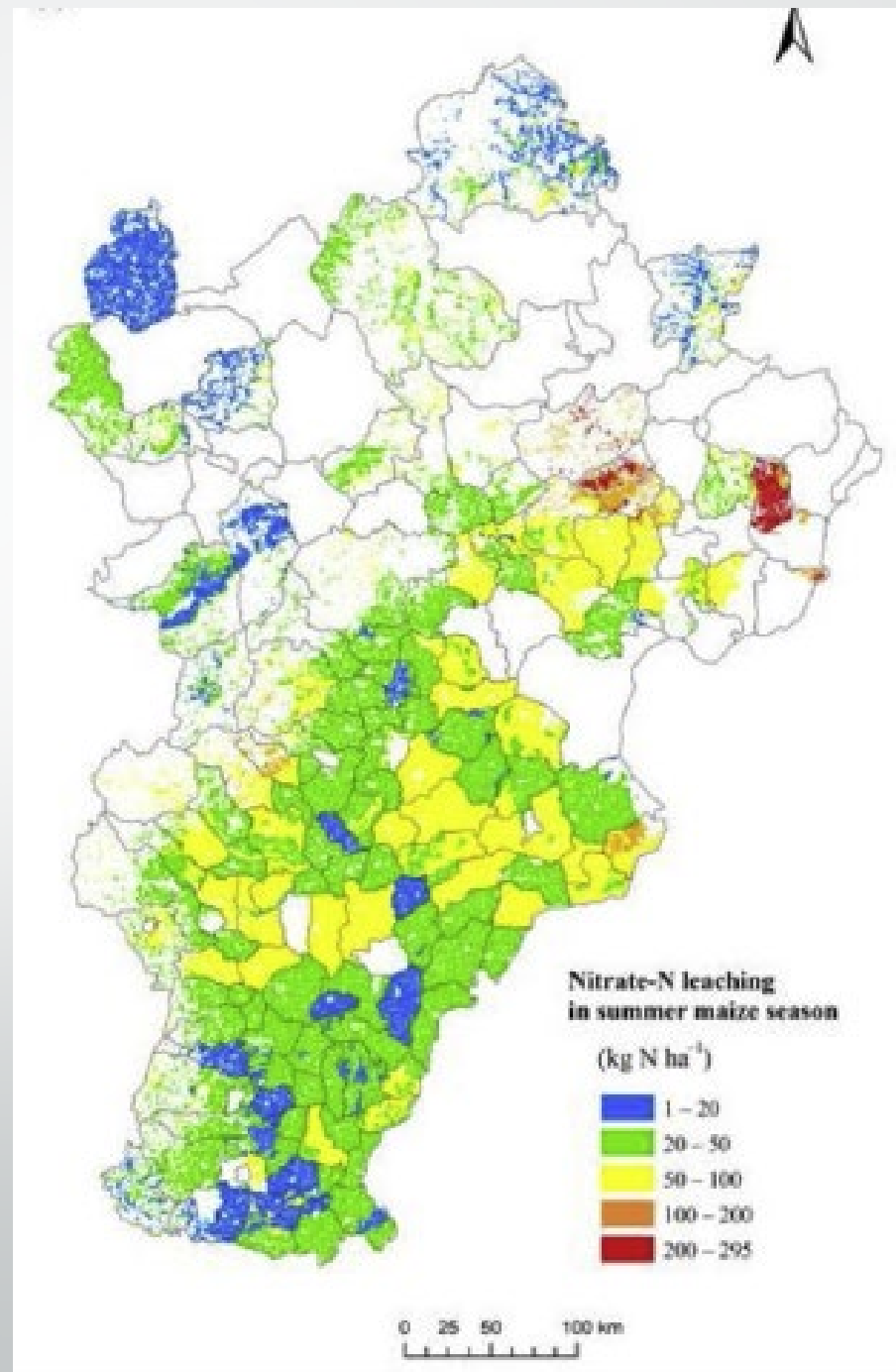
ABSTRACT


Li, Z., X. Wen, C. Hu, X. Li, S. Li, X. Zhang, and B. Hu. 2020. Regional simulation of nitrate leaching potential from winter wheat-summer maize rotation croplands on the North China Plain using the NLEAP-GIS model. *Agriculture, Ecosystems, and Environment* doi: 10.1016/j.agee.2020.106861



From:

Li, Z., X. Wen, C. Hu, X. Li, S. Li, X. Zhang, B. Hu. 2020. Regional simulation of nitrate leaching potential from winter wheat-summer maize rotation croplands on the North China Plain using the NLEAP-GIS model. *Agriculture, Ecosystems and Environment*. doi: 10.1016/j.agee.2020.106861



- 
- **Tier 1, Tier 2 and/or Tier 3 tools can be used to assess and improve nitrogen management to reduce nitrogen losses to the environment.**
  - **Nitrogen management tools can be used to assess nitrogen management rates to improve nitrogen management, yields, and economic returns to farmers.**



Thank you !

Global Symposium on Soils for Nutrition | 26-29 July 2022

