Models and Technological Tools to Improve Fertilizer Recommendations

Dr. Jorge A. Delgado
USDA-ARS-SMSBRU

SOILS: WHERE FOOD BEGINS

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

GLOBAL SOIL PARTNERSHIP

Nitrogen Management

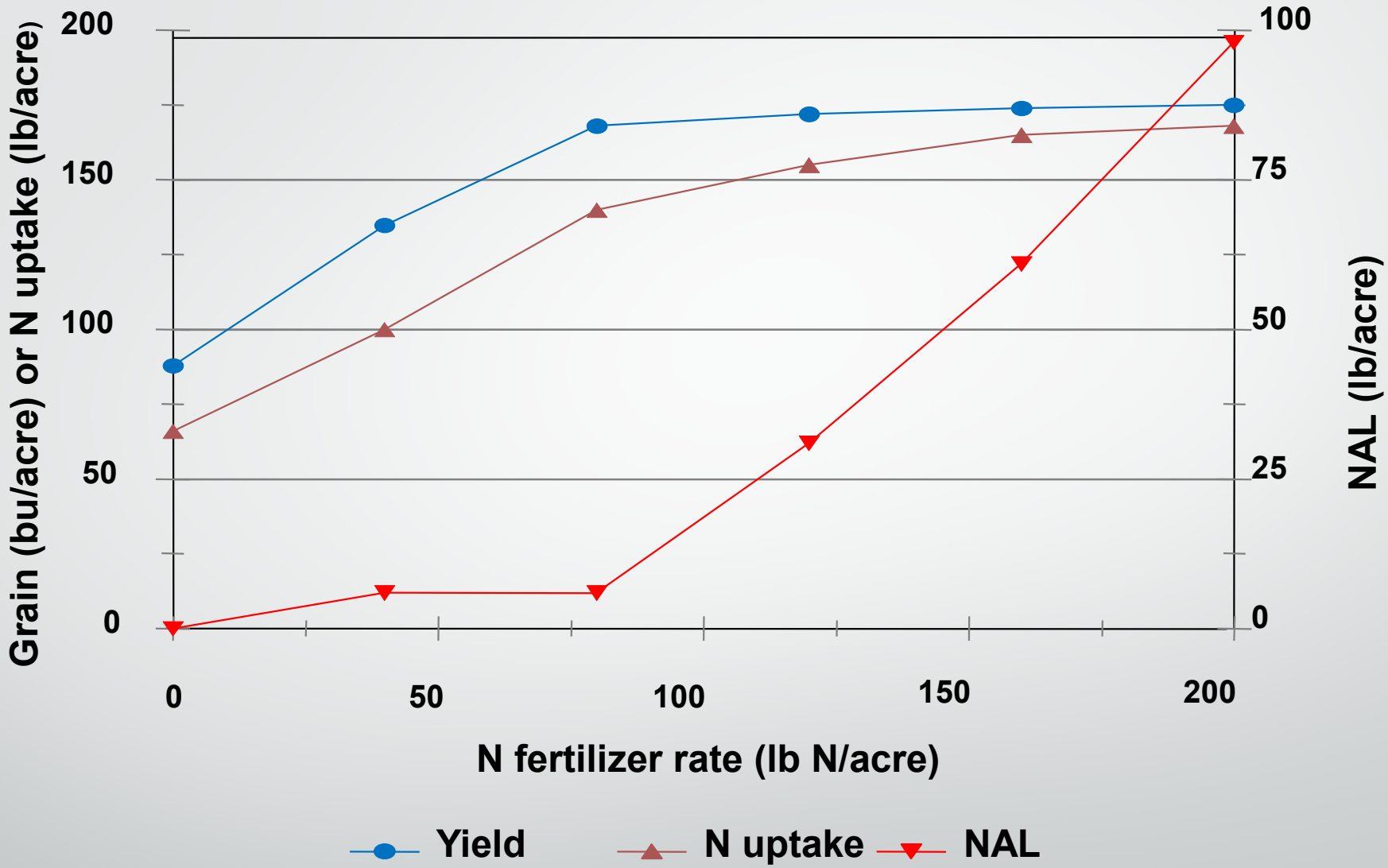
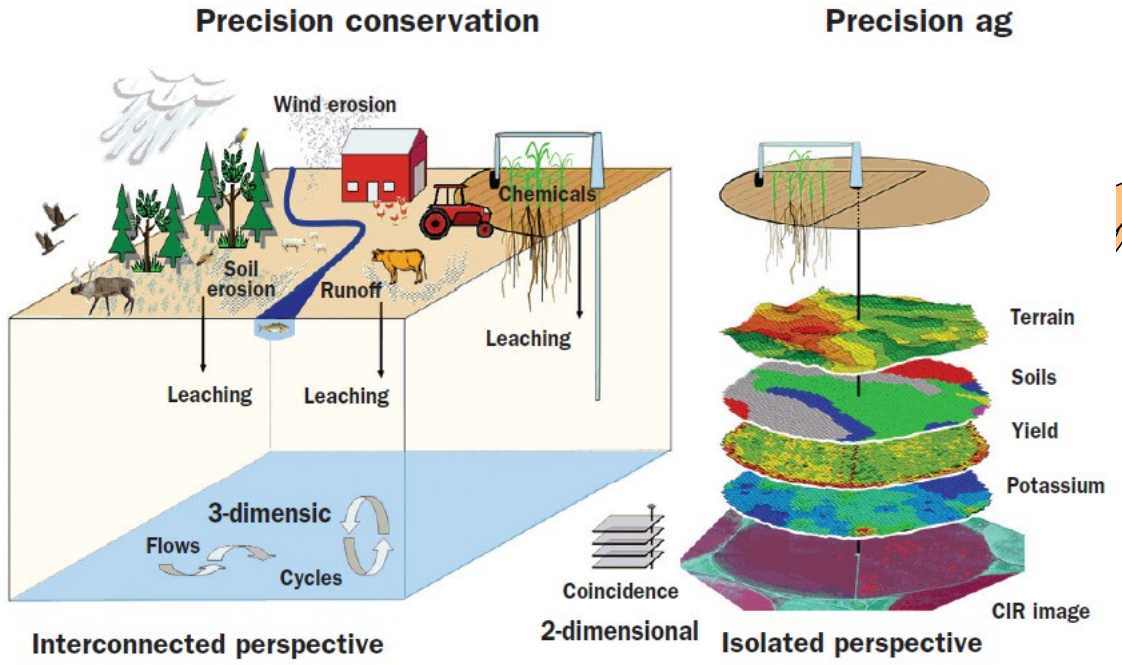


Figure 13. Effect of N fertilizer rate applications on yield and N uptake by irrigated corn (Adapted from Bock and Hergert, 1991). Potential N available to leach (NAL) assuming major pathway for losses is leaching. The NAL was estimated as NAL = N applied – N uptake.

Adapted from: Bock, B.R., and G.W. Hergert, 1991. Fertilizer Nitrogen Management. In: *Managing Nitrogen for Groundwater Quality and Farm Profitability*. p. 139-164. Soil Science Society of America, Madison, WI.

Nitrogen Management of Agricultural Systems



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

Berry, J.K., J.A. Delgado, R. Khosla, and F.J. Pierce. 2003. Precision conservation for environmental sustainability. *Journal of Soil and Water Conservation* 58(6):332-339.

- 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

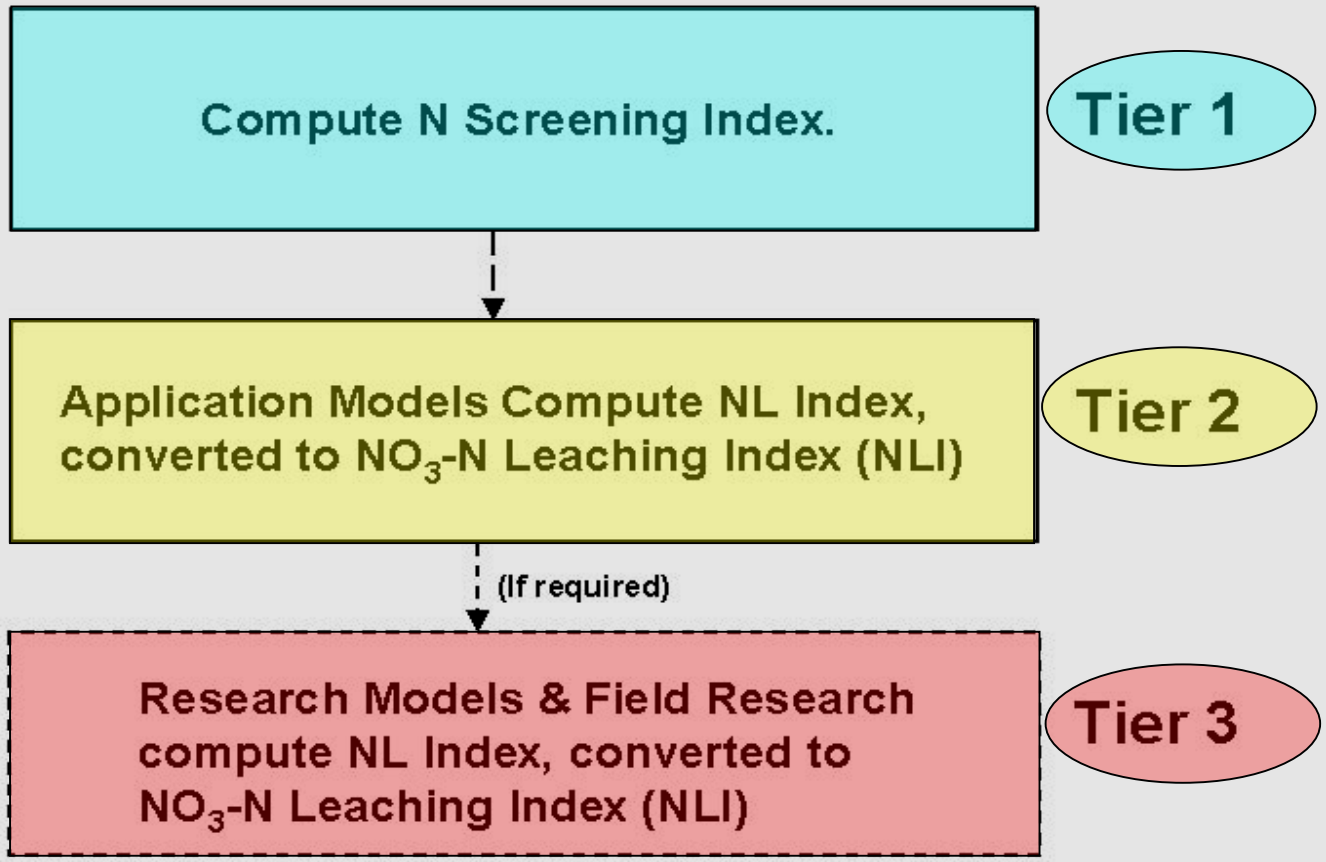


Figure 6. Tier structure of proposed NO_3-N leaching index (NLI) (From Shaffer and Delgado, 2002).

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 4.4.2
File
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Manuals
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P-Index
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California
California
Kentucky
South Dakota
Mexico
Caribbean
Bolivia
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International Soil and Water Conservation Research 5 (2017) 69–75

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International Soil and Water Conservation Research

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Original Research Article

The new Caribbean Nitrogen Index to assess nitrogen dynamics in vegetable production systems in southwestern Puerto Rico☆

Miguel Oliveras-Berrocales[a], David Sotomayor-Ramírez[b], Jorge A. Delgado[c,*], Luis R. Pérez-Alegría[d]

[a] USDA-NRCS, Arkansas: 2603 Federal Building, 100 E, 8th Ave, Pine Bluff, AR 71601, USA
[b] University of Puerto Rico, Mayagüez Campus, College of Agricultural Sciences, Department of Agroenvironmental Sciences, PO Box 9000, Mayagüez, PR 00680, USA
[c] USDA-ARS, Acting Research Leader, Soil Management and Sugar Beet Research Unit, 2150 Centre Ave., Building D, Suite 100, Fort Collins, CO 80526, USA
[d] 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

Original Research Article

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

Uriel Figueroa-Viramontes[a], Jorge A. Delgado[b,*], Juan I. Sánchez-Duarte[a], Esmeralda Ochoa-Martínez[a], Gregorio Núñez-Hernández[a]

[a] INIFAP, Campo Experimental La Laguna, Boulevard José Santos Valdez #1200 Pte., Col. Centro, Matamoros C.P. 27440, Matamoros Coahuila, Mexico
[b] USDA, ARS, 2150 Centre Avenue, Building D, Fort Collins, CO 80526, United States

Ecological Engineering 73 (2014) 778–785

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Use of the new Nitrogen Index *tier zero* to assess the effects of nitrogen fertilizer on N_2O emissions from cropping systems in Mexico

Vinisa Saynes[b], Jorge A. Delgado[a,*], Caleb Tebbe[a], Jorge D. Etchevers[b], Daniel Lapidus[c], Adriana Otero-Arnaiz[c]

[a] USDA-ARS, Soil Plant Nutrient Research Unit, 2150 Centre Avenue, Building D, Fort Collins, CO 80526, United States
[b] Colegio de Postgraduados, Laboratorio de Fertilidad de Suelos y Química Ambiental, Texcoco, Mexico
[c] 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,[1] Jorge A. Delgado,[2] Carlos Monar,[3] Franklin Valverde,[1] Victor Barrera,[1] and Jeffrey Alwang[4]

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

Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

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

Jose M. De Paz[a,1], Jorge A. Delgado[b,*], Carlos Ramos[a,2], Marvin J. Shaffer[c], Kenneth K. Barbarick[d]

[a] 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
[b] USDA-ARS, Soil and Plant Nutrient Research Unit, 2150 Centre Avenue, Building D, Suite 100, Fort Collins, CO 80526, USA
[c] USDA-ARS (retired), Loveland, CO 80538, USA
[d] Soils and Crops Department, Colorado State University, Fort Collins, CO 80523, USA

ECOLOGICAL ENGINEERING 32 (2008) 108–120

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ecoleng

An index approach to assess nitrogen losses to the environment☆

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

[a] Soil Plant Nutrient Research Unit, USDA, Agricultural Research Service, 2150 Centre Avenue, Building D, Suite 100, Fort Collins,CO 80526, United States
[b] 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

Original Research Article

Use of the Nitrogen Index to assess nitrate leaching and water drainage from plastic-mulched horticultural cropping systems of Florida☆

Edilene C.S. Marchi[a,b,d], Lincoln Zotarelli[b], Jorge A. Delgado[c,*], Diane L. Rowland[d], Giuliano Marchi[e]

[a] Instituto Federal de Educação, Ciência e Tecnologia de Brasília, Campus Planaltina, DF, Rodovia DF-128 - 21 - Zona Rural de Planaltina, Brasília-DF 73380-900, Brazil
[b] University of Florida - Horticultural Science Department, 1241 Fifield Hall, Gainesville, FL 32611, USA
[c] 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**[1], Jorge A. **Delgado**[2*], Ruben **Botello**[1], Pablo **Mamani**[1], Jeffrey **Alwang**[3]

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

ABSTRACT

ABSTRACT

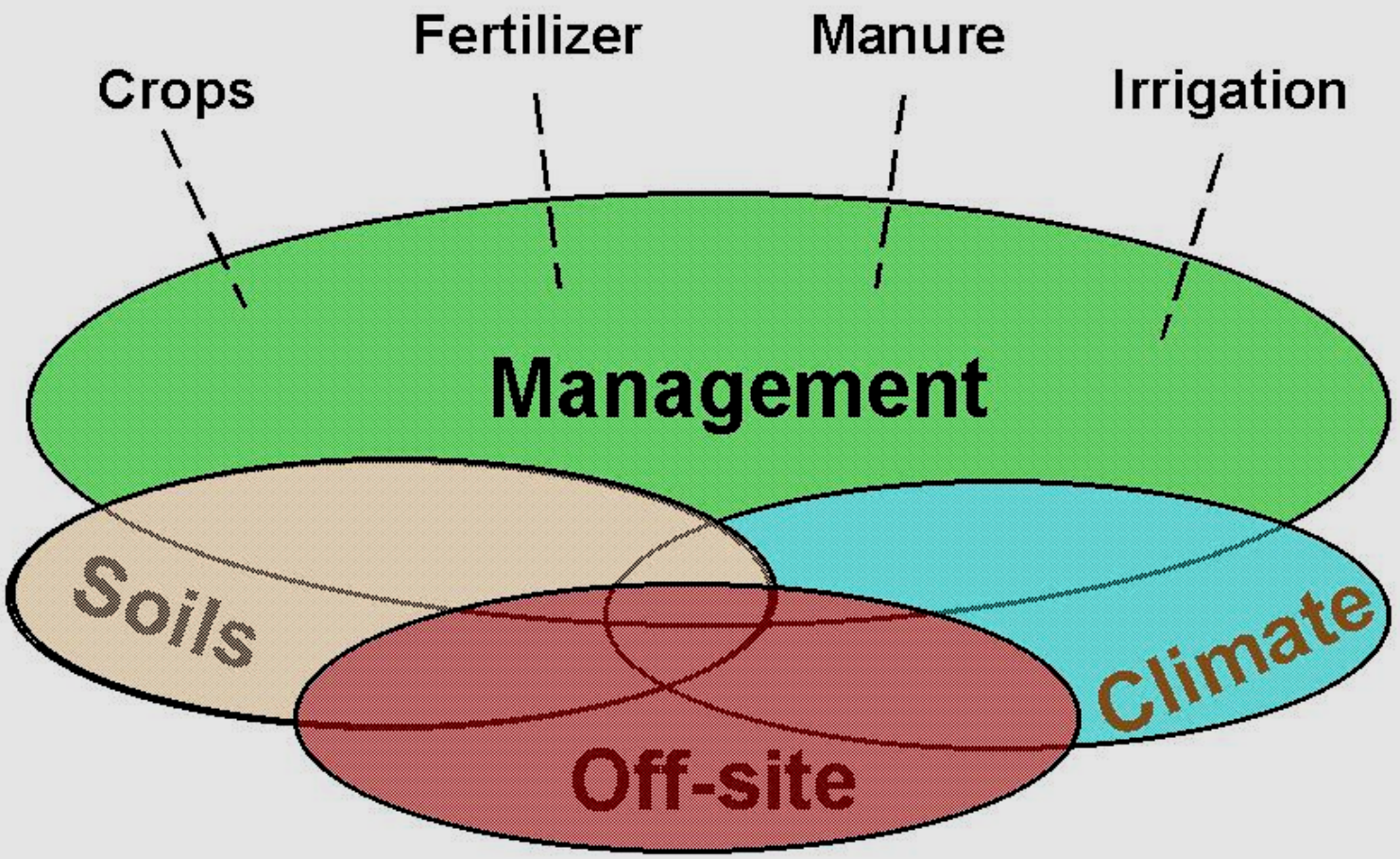


Figure 5. Essential components of NO_3-N leaching index (NLI) (From Shaffer and Delgado, 2002).

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

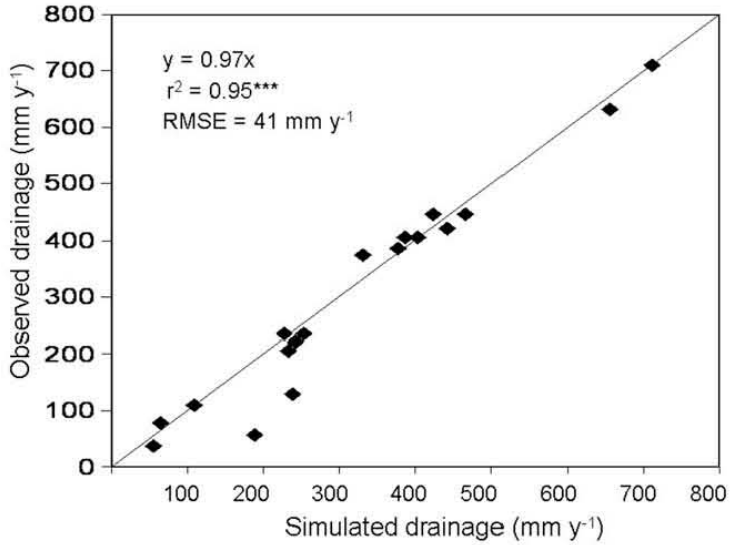


Figure 3. Calibration of observed vs. simulated drainage with the GIS nitrogen index tier one (GIS NIT-1) tool.

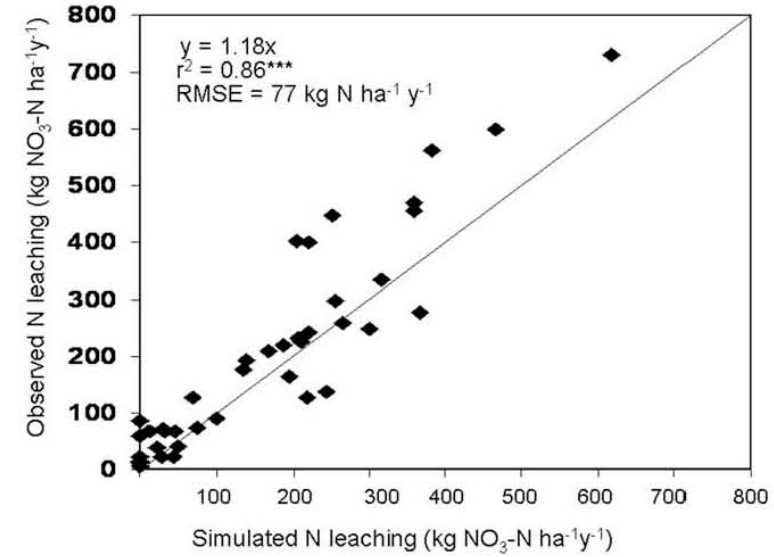


Figure 5. Calibration of observed vs. simulated nitrate leaching with the GIS nitrogen index tier one (GIS NIT-1) tool.

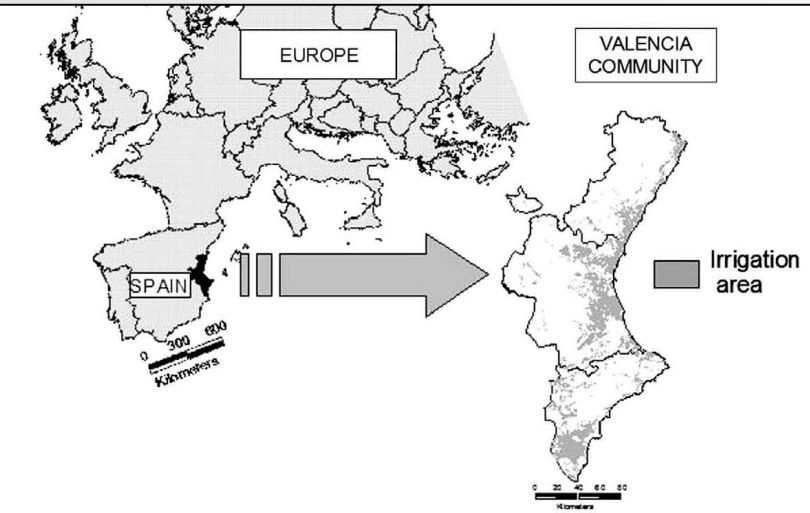
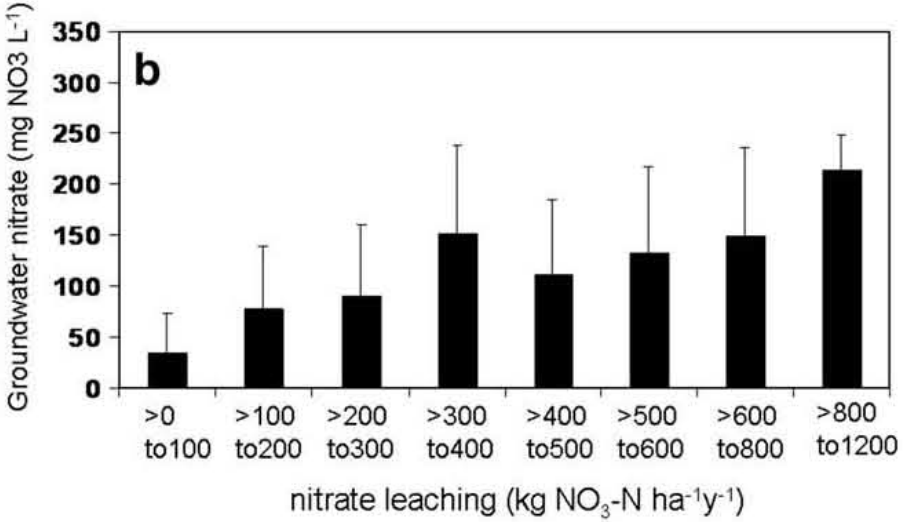


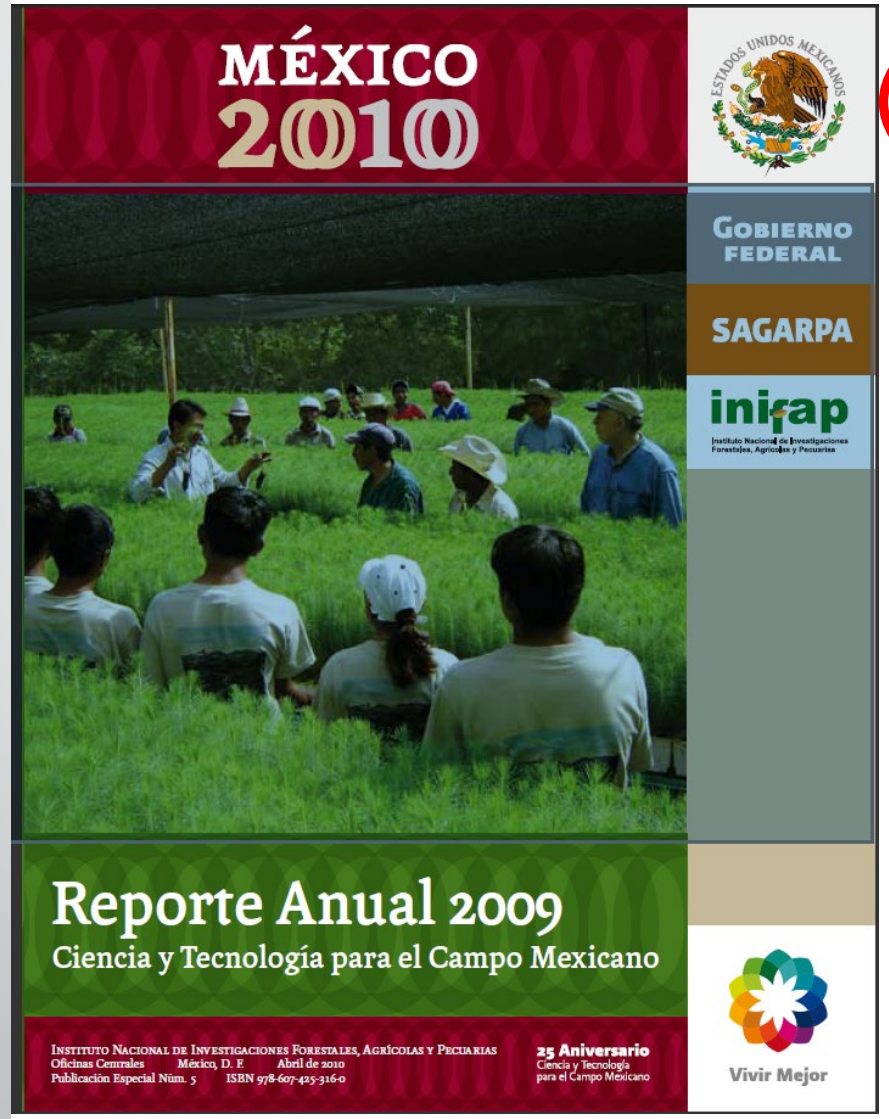
Figure 1. Study area location.



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



- 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 pastoreo; 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 Trópico 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 obtuvo rendimientos de proteína cruda similares a la alfalfa, pero con mayores rendimientos de materia seca (62%) y energía neta de lactancia (77%), así como incrementos de 60 y 75% en los valores de eficiencia en el uso de agua en producción de materia seca y energía neta de lactancia por m³ de agua.
- Con las evaluaciones genéticas de toros Holstein se continuó la identificación de sementales sobresalientes con habilidad predicha 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
- 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.

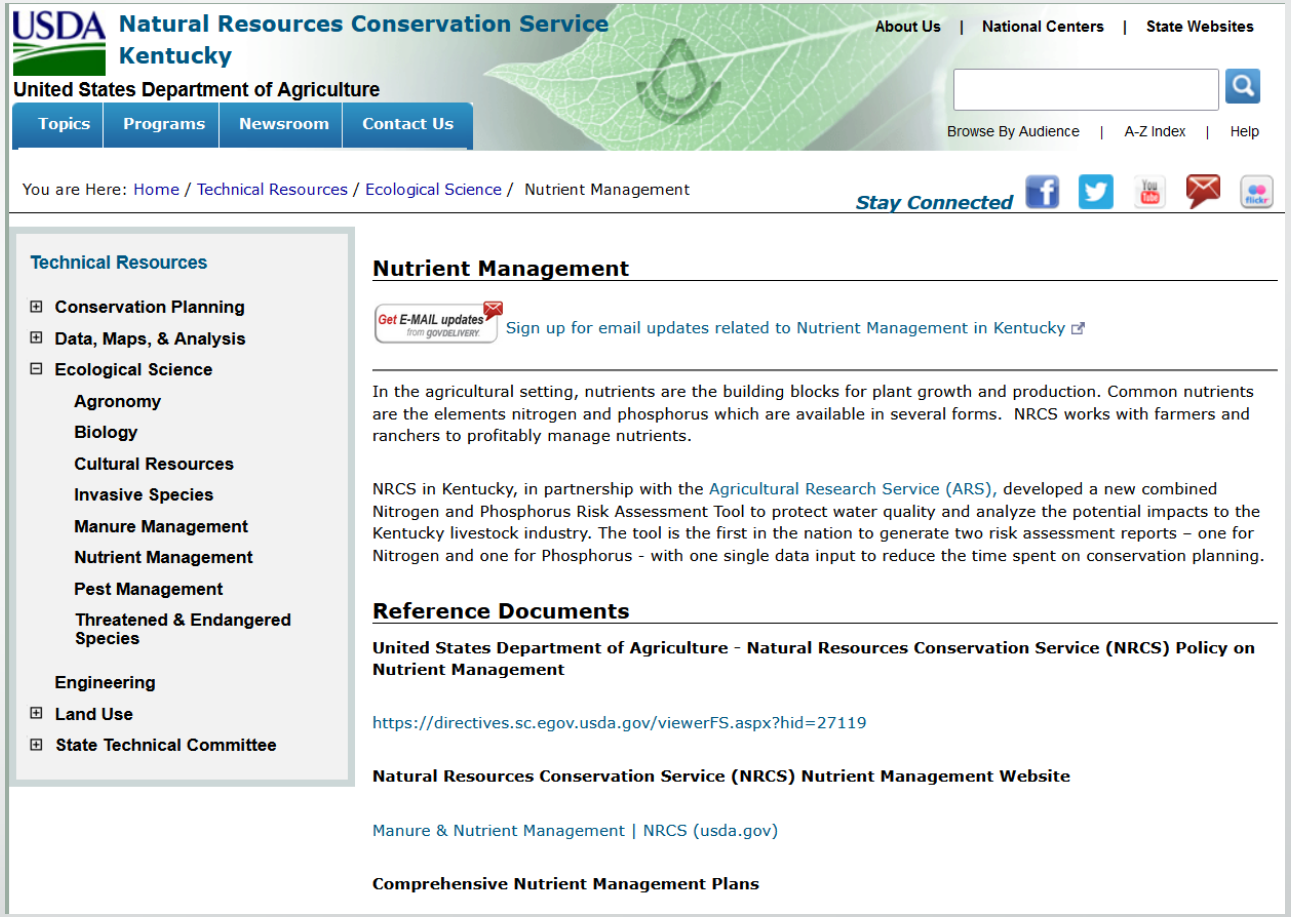
- Manuales de producción de leche de bovino para los sistemas de lechería especializado, familiar y doble propósito en los cuales se presentan los conocimientos y tecnologías disponibles, así como un enfoque de procesos para su aplicación en las unidades de producción.

Team Efforts Across Nations: Case Scenarios

Kentucky, USA

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."



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."

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

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[a,b,c], Xiumei Wen[b], Chunsheng Hu[a,*], Xiaoxin Li[a], Shanshan Li[b], Xiaosen Zhang[b], Baoqing Hu[b,c]

[a] *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*

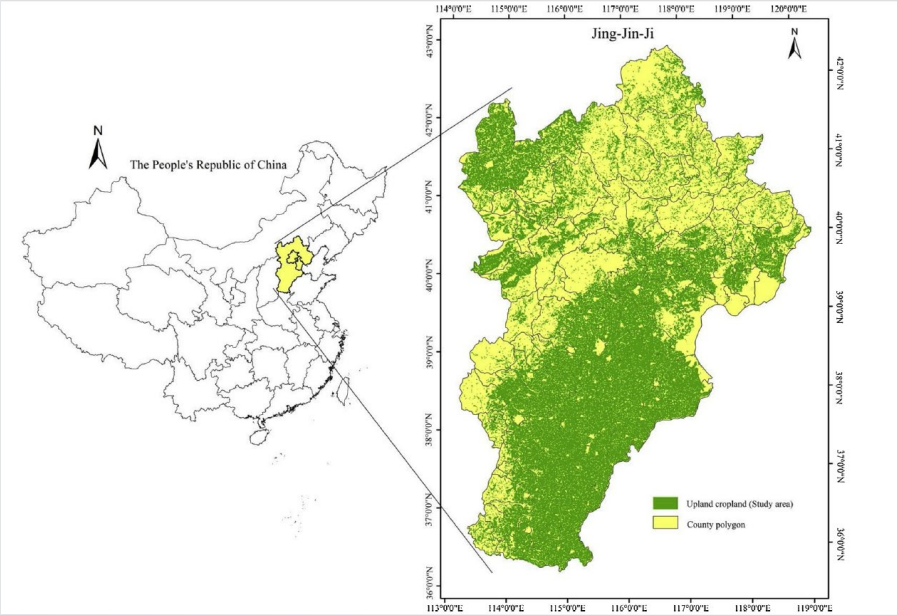
[b] *Key Laboratory of Environment Change and Resources Use in Beibu Gulf, Ministry of Education, Nanning Normal University, 175 East Mingxiu Road, Nanning 530001, China*

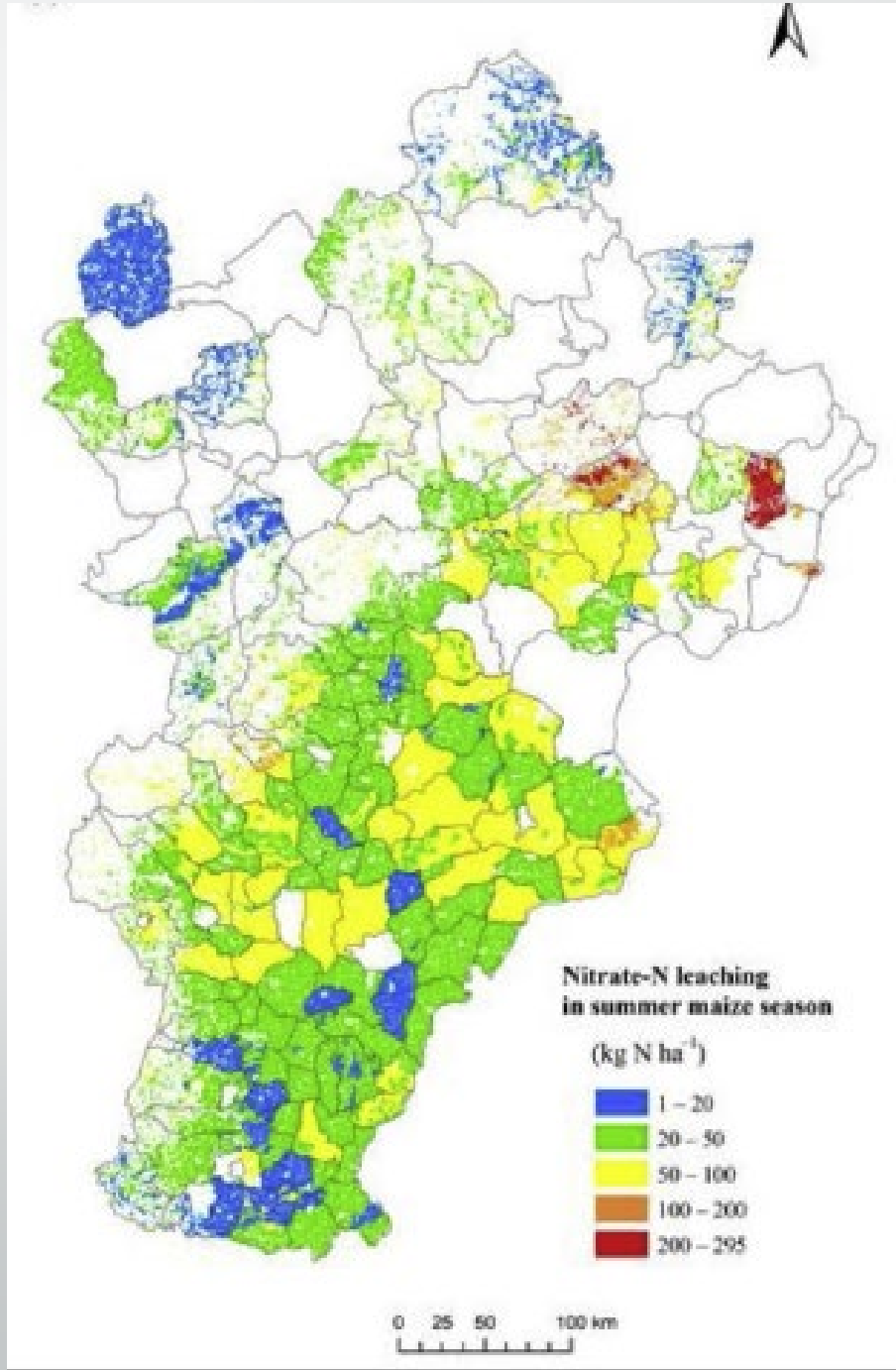
[c] *Guangxi Key Laboratory of Earth Surface Processes and Intelligent Simulation, Nanning Normal University, 175 East Mingxiu Road, Nanning 530001, China*

ARTICLE INFO

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 Environmen*t. 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 !
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