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"Grassroots Action" in Livestock Feeding to Help Curb Global Climate Change

Scientists meeting in Australia describe how they are turning a dream into reality, with major benefits for people and the environment

In a series of papers prepared for the 22nd International Grasslands Congress, scientists offer new evidence that a potent chemical mechanism operating in the roots of a tropical grass used for livestock feed has enormous potential to reduce greenhouse gas emissions.

Referred to as "biological nitrification inhibition" or BNI, the mechanism markedly reduces the conversion of nitrogen applied to soil as fertilizer into nitrous oxide, according to papers prepared for the 22nd International Grassland Congress in Sydney on 15-19 September 2013 – a pre-eminent global forum held only every four years. It is to be attended by over 1000 delegates from more than 60 countries.

Nitrous oxide is the most powerful and aggressive greenhouse gas, with a global warming potential 300 times that of carbon dioxide.

"Nitrous oxide makes up about 38 percent of all greenhouse gas emissions in agriculture, which accounts for almost a third of total emissions worldwide," said Michael Peters, who leads research on forages at the Colombia-based International Center for Tropical Agriculture (CIAT), a member of the CGIAR Consortium. "BNI offers what could be agriculture's best bet for keeping global climate change within manageable limits."

Scientists at CIAT and the Japan International Research Center for Agricultural Sciences (JIRCAS) have researched BNI collaboratively for the last 15 years.

"This approach offers tremendous possibilities to reduce nitrous oxide emissions and the leaching of polluting nitrates into water supplies, while also raising crop yields through more efficient use of nitrogen fertilizer," said G.V. Subbarao, a senior scientist at JIRCAS.

As a result of recent advances, scientists have developed the means to exploit the BNI phenomenon on a large scale:

- CIAT researchers have found ways to increase BNI through plant breeding in different species of *Brachiaria* grasses. The new techniques include methods for rapidly quantifying BNI in *Brachiaria* together with molecular markers, which reduce the time needed for field testing.
- Center scientists have also just gathered evidence that a maize crop grown after *Brachiaria humidicola* pastures gave acceptable yields with only half the amount of nitrogen fertilizer normally used, because more nitrogen was retained in the soil, thus reducing nitrous oxide emissions and nitrate leaching. The researchers determined that BNI had boosted nitrogen-use efficiency by a factor of 3.8.
- In addition, scientists have developed hybrids of *Brachiaria humidicola* and delivered these, with support from the German government, to farmers in Colombia and Nicaragua for productivity and quality testing. Previous grass hybrids have increased milk and meat production by several orders of magnitude, compared to native savanna grasses, and by at least 30 percent, compared to commercial grass cultivars. Based on evaluation of the new hybrids and with the aid of simulation models, researchers are studying where else the hybrids can be introduced and on how large a scale.

"Livestock production provides livelihoods for a billion people, but it also contributes about half of agriculture's greenhouse gas emissions," Peters explained. "BNI is a rare triple-win technology that's good for

rural livelihoods as well as the global environment and climate. It defies the widespread notion that livestock are necessarily in the minus column of any food security and environmental calculation."

"The problem is that today's crop and livestock systems are very 'leaky,'" said Subbarao. "About 70 percent of the 150 million tons of nitrogen fertilizer applied globally is lost through nitrate leaching and nitrous oxide emissions; the lost fertilizer has an annual estimated value of US$90 billion."

"BNI has huge possibilities for reducing nitrogen leakage," said CIAT scientist Idupulapati Rao.

"Grassland pastures are the single biggest use of agricultural land—covering 3.2 billion hectares out of a global total of 4.9 billion. In Brazil alone, 11 million hectares of grassland have been converted to maize and soybean production, and another 35-40 million could be shifted to crop production in the near future. Instead of more monocropping, developing countries need to integrate *Brachiaria* grasses into mixed crop-livestock systems on a massive scale to make them more sustainable."

"In the case of Australia," he added, "where nitrogen-based fertilizers are applied to about 32 million hectares, mostly in the form of ammonium phosphate or urea, BNI technology can contribute to an increase in the productivity and profitability of the country's agricultural systems."

Originally from sub-Saharan Africa, *Brachiaria* grasses found their way to South America centuries ago—possibly as bedding on slave ships. Improved varieties of the grass are widely grown on pasturelands in Brazil, Colombia, and other countries, and they have recently been taken back to Africa to help ease severe shortages of livestock feed.

In a major breakthrough, JIRCAS scientists discovered several years ago the chemical substance responsible for BNI and developed a reliable method for detecting the nitrification inhibitor coming from plant roots. Scientists at CIAT then validated the BNI concept in the field, demonstrating that *Brachiaria* grass suppresses nitrification and nitrous oxide emissions, compared with soybean, which lacks this ability.

Other research has shown that deep-rooted, productive *Brachiaria* grasses capture large amounts of atmospheric carbon—on a scale similar to that of tropical forests—a further plus for climate change mitigation.

"Our work on BNI started with a field observation made by one of our scientists in the 1980s—back then it was nothing more than a dream," said Peters. "But now it's a dream with an action plan and solid scientific achievements behind it."

BNI research forms part of a larger initiative referred to as LivestockPlus, which proposes to deliver major benefits for the poor and the environment through innovative research on tropical forage grasses and legumes.

The LivestockPlus initiative takes place within the global framework of the CGIAR Research Program on Livestock and Fish, led by the Kenya-based International Livestock Research Institute (ILRI). The program aims to increase the availability and affordability of meat, milk and fish for poor consumers and raise the incomes of smallholders producing these commodities.

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Other issues- from the internationally significant to the quirky - to be covered include:

- the global food security challenge and the role of livestock
- trade-offs between livestock, human health and the environment
- Australia as a drought hot spot in global grazing lands
- lessons from work underway to control pesky rabbits, squirrels and zokors
- what Mongolia can teach us about control of locusts
- hopes for perennial wheat varieties and the benefits they hold over annual varieties
- new grasses that can deter birds from airfields and sportsgrounds
- the latest technologies like remote sensing, GIS and precision agriculture
- how farms in Asia and Africa could be boosted by garbage bag technology
- what farmers need from grasslands and livestock research
- how to engage more young people in study and careers in agriculture

The International Center for Tropical Agriculture (**CIAT**)—a member of the CGIAR Consortium—develops technologies, tools, and new knowledge that better enable farmers, especially smallholders, to make agriculture eco-efficient—that is, competitive and profitable as well as sustainable and resilient. Eco-efficient agriculture reduces hunger and poverty, improves human nutrition, and offers solutions to environmental degradation and climate change in the tropics. With headquarters near Cali, Colombia, CIAT conducts research for development in tropical regions of Latin America, Africa, and Asia. www.ciat.cgiar.org

The Japan International Research Center for Agricultural Sciences (**JIRCAS**) undertakes comprehensive research on agriculture, forestry and fisheries technology in tropical and subtropical areas and other overseas developing regions, as well as domestic research on agriculture, forestry and fisheries, aimed at providing solutions to international food supply and environmental problems through technology development; and collects, analyzes and publishes information to grasp trends relevant to international agriculture, forestry and fisheries as well as farming systems, through international collaboration and cooperation.
www.jircas.affrc.go.jp

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www.cgiar.org