Response to the Comment by

Artur Granstedt

We are pleased that Professor Granstedt found that the introductory papers (1, 2) of the Ambio Special Issue, and indeed the entire issue, addressed important aspects concerning nitrogen and its action as a beneficial and detrimental agent for human and ecosystem health. As noted in his comments, he does offer some criticism, which for the most part is based on the degree of emphasis, rather than a difference of opinion. In the spirit of constructive dialogue, we are pleased to have this opportunity to respond.

Professor Granstedt's basic criticism of the Special Issue of Ambio—"**Optimizing Nitrogen Management in Food and Energy Production and Environmental Change**"—is that it contained "*insufficient critical analysis of the consequences of changing the agricultural system of the industrialized world from that of the last century, and of possible documented alternatives for reducing emissions of reactive nitrogen to the environment. The decoupling of land where grain is produced from areas in which food animals are reared, is not observed with sufficient clarity that this constitutes the fundamental system defect in man-made agricultural nitrogen cycles, giving rise to a dramatic increase in the surplus (i.e. the difference between inputs and outputs) and hence in emissions of reactive nitrogen, especially in Europe and North America"*.

We agree with Professor Granstedt's assertions that:

i) Decoupling—the physical separation of the land where feed grains are produced from the sites on which food animals are reared—is a very important cause of contemporary changes in the nitrogen cycle of the Earth and many of its beneficial and detrimental effects on human and environmental health, and

ii) "In the future it will be necessary to internalize what are now external environmental costs."

We also agree that decoupling has increased greatly in recent decades – mainly because powerful economic and social forces including economies of scale, efficiency of specialization, cheap food and transportation policies, and global competitiveness in agriculture, have transformed livestock, poultry, and other meat producing industries in many countries. These changes often have led to largely unforeseen environmental problems, mainly on local and regional scales:

Intensification in confined animal feeding operations increases ammonia emissions and nitrate discharges.
Decoupling decreases recycling of nutrients in animal manures and increases emissions of reactive nitrogen (Nr) into the environment.
Regionalization and globalization of markets increase NO_x emissions from transport vehicles as feed, animals, manures, and finished food products are transported—often from Nr-poor to Nr-rich areas—sometimes in far-distant regions or nations.
Vertical integration has great potential to maximize N-use efficiency with integrated economic and advisory-service linkages among farmers, feed suppliers, animal-rearing advisors, and food processing companies. But emphasis on economic efficiency without attention to Nr-induced public health and environmental risks leads to externalization rather than internalization of these real costs.

Thus, a principal challenge for all countries of the world is to develop socially and economically acceptable means to internalize these real environmental costs. We are pleased that Professor Granstedt, with his substantial experience in these matters, particularly with respect to agriculture in the countries surrounding the Baltic Sea, is actively working in one of the most important areas—the use of manure as a resource. His work and that of others will help fulfill the general theme of the Second International Nitrogen Conference—"*Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection*."

RESPONSE TO SPECIFIC COMMENTS

Professor Granstedt comments that Smil (3) does not go on to make the obvious point that animal manure could be recycled. In response, we note that (a) V. Smil covers this topic in great detail in two books (4, 5), (b) that the scope of his paper in Ambio was on the relationship of nitrogen and food production, a very