PRECISE-FERTILIZATION AS AN ADDED VALUE FOR FARM PRODUCTS BY INCREASING GLOBAL AWARENESS ON HEALTH AND ENVIRONMENTAL EFFECTS

Sulis Dyah Candra[1] and Ketut Anom Wijaya[2]

Abstract

Intensive nutrient managements for crop production are one of agriculture management strategies that are not yet widely adopted in most third world countries. Precise N Fertilization as a part of intensive nutrient managements is a great way to manage input efficiency; yet, the technology is feasible enough for farmers to apply, in order to increase the farm product quality while improve access in modern market. Nitrogen (N) required for plant growth and development in large numbers, but the plant is only capable of absorbing an average of less than 50% N provided through conventional fertilization. Greenhouse gases emissions are increasing mostly because of expanding use of N fertilizers, while the carcinogenic effect of N residue on farm products is a dangerous risk for human health. By increasing the awareness on health and environmental effects for farm products especially concerning precise N fertilization, consumer will get health benefit while producer will get an added value for their products. Thus, by applying better input efficiency farmers could simultaneously increase the price while meeting the higher consumer demands even with gradually stricter standards in term of farm product quality and market requirements.

Keywords*: Precise N Fertilization; farm product added value*

Introduction

Agricultural input efficiency is technically one of the most important farm products daunting challenges, despite problems on falling prices and meeting gradually higher consumer demands. Respectively, by applying better input efficiency eventually farmers could simultaneously increase the price while meeting the higher consumer demands even with gradually stricter standards in term of product quality and market requirements. Precise agricultural soil management is an important approach to avoid excessive nitrogen.

Excessive Nitrogen Effect on Human Health

The quality of vegetables is determined by several criteria which include physical integrity, color, and flavor. However, since the increased public awareness of health, consumer demands for better quality of vegetable product; some of these are the levels includes pesticide residues, heavy metals, and nitrates.

[1] Faculty of Agriculture, Panca Marga University, Probolinggo, Indonesia, e-mail: sulisdyah@gmail.com
[2] Faculty of Agriculture, Jember University, Indonesia, e-mail: anomwijaya143@yahoo.co.id

Nitrogen is considered the plant nutrient most widely deficient in the world's soils. Various agricultural practices have therefore been developed to increase its concentration in the soil. These practices include incorporating legume varieties in pasture and applying various nitrogen-rich fertilizers (urea, sulfate of ammonia, blood and bone) to crops; such practices sometimes cause plants grown in these soils to have nitrate levels above safe limits, resulting in livestock poisonings [1].

Agriculture is also the largest producer of both methane and nitrous oxide, which together make up about 22 percent of global emissions [2]. A robust finding is that reduced nitrogen inputs result in reduced nitrous oxide emissions. This effect is particularly strong for shifts from very high to medium nitrogen fertilization levels [3]. Nitrous oxide emissions are particularly difficult to quantify, as they are highly dependent on many factors such as the local small-scale weather conditions as well as on the particular fertilizer type used, soil and crop characteristics, management techniques and so on. Overall global agricultural emissions, for which are counting direct agricultural emissions plus input production and energy use, but land use change is disregarded, are composed of about 41 percent nitrous oxide, 49 percent methane and 10 percent carbon dioxide [4].

Understanding carcinogenesis is critical for development of rational approaches to cancer prevention. The hypothesis linking nitrate and increased risk of cancer rests on the proposition that nitrate is endogenously reduced to nitrite by bacteria and that carcinogenic N-nitroso compounds are formed. A large number of foods and biological material have been examined for their ability to generate mutagens or carcinogens under simulated gastric conditions in the presence of nitrite. It appears to be potential link between formation of the nitroso compound and epidemiological evidence of increased risk for specific cancers [5].

N-Nitroso compounds can induce cancer in experimental animals. Some representative compounds of this class induce cancer in at least 40 different animal species including higher primates. Tumors induced in experimental animals resemble their human counterparts with respect to both morphological and biochemical properties. Extensive experimental, and some epidemiological data suggest that humans are susceptible to carcinogenesis by N-nitroso compounds and that the presence of these compounds in some foods may be regarded as an aetological risk factor for certain human cancers, including cancer of the oesophagus, stomach and nasopharynx [6].

The carcinogenic effect of nitrosamines in tobacco products is one of the most extensive experiments. Several tobacco-specific nitrosamines have been considered as possible causative agents for human cancer. Nitrosamines may be implicated in the induction of certain human gastric cancers [7]. Diminishing human exposure to these carcinogens is one approach to prevention of cancer, although exposure to N-nitrosamine in tobacco products is still unacceptably high. Carcinogenic N-nitroso compounds are formed from the reaction of naturally-occurring amines and nitrites that may be added to foods or produced by bacterial reduction of nitrate. N-Nitroso compounds can be produced during processing, storage and preparation of foods and in the mammalian stomach. Factors that influence the rates of nitrosation reactions include pH, temperature, catalysts, and inhibitors [14].

Excessive Nitrogen Effect on Human Environment

Nitrogen essentially needed by plants as the building blocks of proteins, enzymes, chlorophylls, phyto-hormones and some other compounds. Plants generally obtain N from organic material that has undergone mineralization process in the form of nitrate and ammonium. Unabsorbed nitrogen by plants will turn into N_2O and NH_3 gasses. N_2O will evaporate and accumulate in Earth's atmosphere layers that could cause an increase Earth surface temperature (Global Warming). Most of N will undergo leaching and contaminating groundwater, while some will be carried away by the flow of surface water (run-off) and contaminate bodies of water such as rivers, reservoirs, etc. In general, N loss from crop fertilization is >89% through leaching, erosion, runoff, volatilization gas (NH_3) and de-nitrification (N_2, NO_2, NO, N_2O) [8].

Nitrous oxide as other form of Nitrogen is produced naturally in soils through the microbial processes of de-nitrification and nitrification. Natural emissions of N_2O can be increased by a variety of agricultural practices and activities, including the use of synthetic and organic fertilizers. Natural emissions of N_2O primarily result from bacterial breakdown of nitrogen in soils and in the earth's oceans. Human impacts can significantly enhance the natural processes that lead to N_2O formation. For example, the nitrogen nutrient loading in water bodies due to fertilization and run-off to streams can enhance N_2O emissions from these natural sources. Human-related ammonia emissions have also been shown to cause N_2O emissions in the atmosphere through ammonia oxidation.

The most important source of nitrous oxide emissions are fertilized soils. A certain part of the nitrogen applied to soils via organic and mineral nitrogen fertilizers or green manure and other forms of plant residues is emitted as nitrous oxide, which is generated through soil microbial processes. These nitrous oxide emissions account for more than 40 percent of the sector's overall emissions. Nitrous oxide emissions are particularly difficult to quantify, as they are highly dependent on many factors such as the local small-scale weather conditions as well as on the particular fertilizer type used, soil and crop characteristics, management techniques and so on. Agricultural lands occupy about 40-50% of the Earth's land surface. Agriculture releases to the atmosphere significant amounts of CO_2, CH_4, and N_2O. CO_2 is released largely from microbial decay or burning of plant litter and soil organic matter. CH_4 is produced when organic materials decompose in oxygen-deprived conditions, notably from stored manures and from rice grown under flooded conditions. N_2O is generated by the microbial transformation of nitrogen in soils and manures. Nitrous oxide emissions were largest in areas where a large portion of land is used for intensive agriculture. N_2O is often enhanced where available nitrogen (N) exceeds plant requirements, especially under wet conditions. In general, N_2O emissions are highly correlated with crop areas and nitrogen inputs. Synthetic fertilizer makes up about half of total N additions, followed by fixation and manure. Globally, agricultural CH_4 and N_2O emissions have increased by nearly 17% from 1990 to 2005. In South Asia, greenhouse gases emissions are increasing mostly because of expanding use of N fertilizers and manure [9].

The Nitrogen nutrient loading in water bodies due to fertilization and run-off to streams can enhance N_2O emissions from these natural sources. Human-related ammonia emissions have also been shown to cause N_2O emissions as an important Green House Gasses (GHG) contributor in the atmosphere, through ammonia oxidation [10].

Intensive nutrient managements for crop production are one of agriculture management strategies that are not yet widely adopted in most third world countries. Maize cultivation in Indonesia for instance, is still highly inefficient in N fertilizer application with the loss of 50-58% N, while in the USA the loss is about 14-41%. Even in lowland rice cultivation in Indonesia occurred at 77-89% loss of N [8].

Awareness and Added Value

By increasing the awareness on health and environmental effects for farm products especially concerning precise N fertilization, consumer will get health benefit while producer will get an added value for their farm products. Thus, by applying better input efficiency farmers could simultaneously increase the price while meeting the higher consumer demands even with gradually stricter standards in term of farm product quality and market requirements.

What the agriculturally-based-third-world-country need is value added agriculture, which involves taking the product to the next level before selling. With adding an extra value to the farm products - an extra level of sophistication of world healthier and environmental awareness trend – could overcome classic problems, such as: the farm product which is usually sold at an average price (minimum amount of profit) or even below cost production (that in the long-term could threat farmers to cover operating agricultural practices, while farmer as small scale enterprise is already more vulnerable to losses yields).

The reduced use of less N fertilizer simultaneously decrease costs and pollution, which is a consequence of methods of synthesis of uptake by crops while overcoming the inefficient N fertilizer application; achievement of these goals is urgently required [11].

Conclusion

Precise fertilization, especially for nitrogen, is in alignment with a long term modern agricultural objective of improving crop N-use and yield with fewer inputs and less pollution; which requires better awareness, understanding and application of in-farm and off-farm efficiency, especially for farmers to increase profit through better farm product quality as an added value.

In scarcity, N will be the limiting plant growth factor, but in adverse case where N supply is abundance. The available nitrogen usually exceeds plant requirements while enhancing N_2O [9] or, adding nitrogen, however, often stimulates N_2O emissions as Green House Gasses [12]. A large part of global agriculture uses N-fertilizer very inefficiently (even in developed economies) often because other environmental conditions are limiting so improvement in technology for N-application, as well as application of current best practice, could reduce losses and increase production [8]. In modern agriculture, the production of large yields of high quality products with the minimal input of resources, particularly N fertilizers, is the main aim [13].

Precise N Fertilization as a part of intensive nutrient managements is a great way to manage input efficiency; yet, although the technology (such as N-mineral fertilizer Method) is feasible enough for farmers to apply, basic practical field application manual is still needed to be widely spread especially among farmers. By integrating the government role as well as industrial and university involvement, it would be just the matter of time for small scale farmer in order to increase the farm product quality while improve access in modern market.

References

[1] S. Robson, Nitrate and Nitrite Poisoning in Livestock. Primefact 415. State of New South Wales through NSW Department of Primary Industries. 2007. ISSN 1832-6668.

[2] K.A. Baumert, T. Herzog, J. Pershing, Navigating the Numbers. Greenhouse Gas Data and International Climate Policy. Washington D.C., World Resources Institute. 2005. http://pdf.wri.org/navigating_numbers.pdf [21.05.2012]

[3] A. Bouwman, L. Boumans, N. Batjes, Emissions of N_2O and NO from fertilized soils: summary of available measurement data. 2002. Global Biogeochemical Cycles 16(4)

[4] J. Bellarby, B. Foereid, A. Hastings, P. Smith, Cool Farming: Climate impacts of agriculture and mitigation potential. Greenpeace International, Amsterdam, the Netherlands. 2008. http://www.greenpeace.org/international/Global/international/planet-2/report/2008/1/cool-farming-full-report.pdf [15.05.2012]

[5] SR Tannenbaum SR, Diet and Exposure to N-nitroso compounds. Princess Takamatsu Symp. 1985; 16:67-75.

[6] A.R. Tricker, R. Preussmann R, Carcinogenic N-nitrosamines in the diet: occurance, formation, mechanisms and carcinogenic potential. Mutat Res. 1991 Mar-Apr; 259(3-4):277-89.

[7] J.K. Lin, Nitrosamines as Potential Environmental Carcinogens in Man. Taipei, China. Clin Biochem. 1990 Feb; 23 (1): 67-71.

[8] PE. Bacon (Ed.), Nitrogen Fertilization, in the Environment. 1995. New York: Marcell Dekker Inc.

[9] P. Smith, D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, Agriculture. In: Metz, B., Davidson, O.R., Bosch, P.R., Dav, R., Meyer, L.A. (Eds.), Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the

Intergovernmental Panel on Climate Change. 2007. Cambridge University Press, Cambridge, United Kingdom and New York, USA

[10] EPA, US Emissions Inventory 2010: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008. 2010. http://epa.gov/climatechange/emissions/usinventoryreport.html [15.05.2012]

[11] MW. Ter Steege, I Stulen, B. Mary, Nitrogen in the Environment in: [Lea PJ, Morot-Gaudry J-F, eds.] Plant Nitrogen. 2001. Berlin. pp 379-397.

[12] RT. Conant, K. Paustian, S.J. Del Grosso, and W.J. Parton, Nitrogen pools and fluxes in grassland soils sequestering carbon. *Nutrient Cycling in Agroecosystems*, 2005: b 71, pp. 239-248

[13] DW. Lawlor, Carbon and Nitrogen Assimilation in Relation to Yield: Mechanism are the key understanding production system. 2001. UK. [http://jxb.oxfordjornals.org/content/53/370/773.full]

Article in A Conference Proceedings:

[14] Hecht SS, Approaches to cancer prevention based on understanding of N-nitrosamine carcinogenesis. Proc Sos Exp Biol Med. 1997 Nov; 216(2): 181-91.