CONTROL OF NITRATE LEACHING IN AGRICULTURE FARMS

For quite some time now, the influence as carcinogenic agents of the compounds named nitrosamines has been known. Concern over these compounds increased in Europe in the late 1980s, when high levels of nitrates were found in certain aquifers and well waters. Nitrates, when consumed in high doses, can increase the concentration of nitrosamines in the body through their reduction to nitrites. This problem led to the first European laws for control of aquifer contamination in the early 1990s, though these laws, when applied in the different member states of the European Union, have undergone a number of changes. At the same time, legislation was created regarding nitrate content inedible parts of vegetables such as lettuce. At present, similar legislation and corrective measures are being developed in areas outside the European Union, such as in California, one of the leading agricultural states of the USA.

Crop fertilization is based in large measure on the application of different forms of nitrogen, such as urea, ammonium or nitrate salts, or various organic compounds. Natural chemical processes unavoidably lead all these forms to turn into nitrates, either through urea hydrolysis processes, nitrification of the ammonia, or mineralization of the organic materials. For its part, the reduced size of the nitrate, its negative charge, and the high solubility of its salts, makes it unlikely to be retained in the soil (which generally has a negative charge as well). Thus, it frequently leaches to deep layers, easily reaching aquifers.

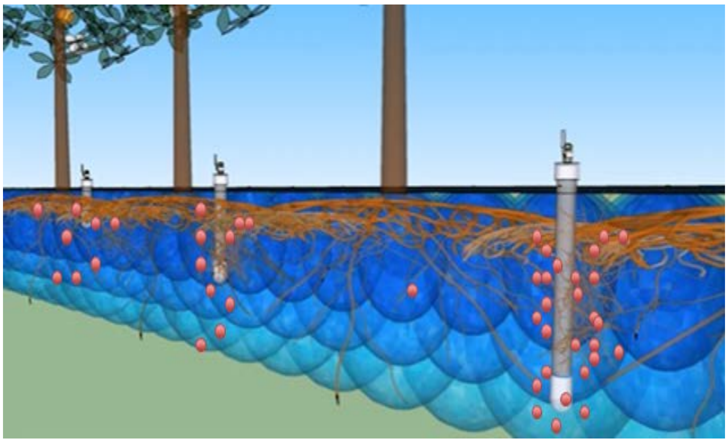
Excess applications of nitrogen on agricultural crops thus become an important source of aquifer pollution by nitrates. Yet even though this is well known, it is hard to establish methodologies to control or record the leaching, other than through the subsequent measure of its level in the aquifer. The movement of ions through the soils affected by geological aspects that are difficult to evaluate (depths and characteristics of the horizons, their slope, as well as the depth and location of the aquifers, etc.). Thus, it is not very useful to try to determine the kilograms of leached nitrates on a specific farm.

To solve this problem, a new approach is being developed that makes it possible to evaluate this phenomenon and propose concrete measures that are more operative and reliable. What is done is to make a determination of the percentage of efficiency of the application of nitrogen. Regardless of the quantity of leached nitrate, if the efficiency of the nitrogen applications increases, contamination will decrease. Stated in other terms, the more that the application of nitrogen is in keeping with the demand of the crop, the less can be lost to leaching.

Following this new approach, AGQ Labs is developing a change in its Crop Nutritional Monitoring technology, based on lysimeters installed at different depths. This method is based on three aspects.

1. A soil mapping of the farm, to find the zones that pose the greatest risk of leaching, based on the orography and on physical and chemical properties.

2. Evaluation of the nitrogen contribution in the different zones chosen. The fertilization plan is evaluated, and is corroborated and adjusted through an analysis of the fertilizer solution applied.
3. Evaluation of the composition of the soil solution at different depths in the zones chosen. Through certain specific calculations that make comparisons with the nitrogen contributed, the percentage of efficiency of the plant's use of nitrogen is calculated.

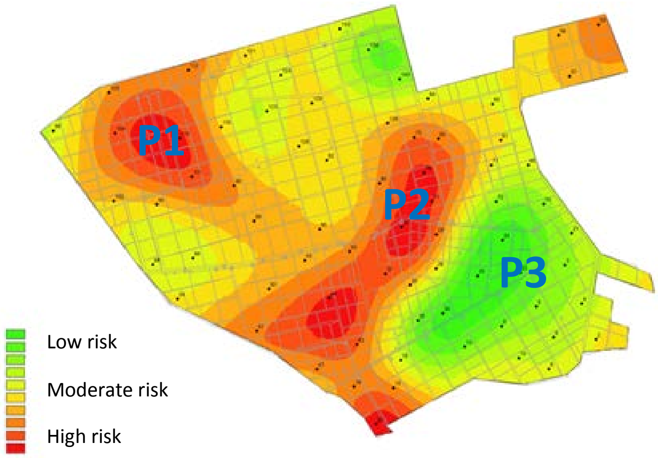


This methodology has made it possible to conduct an evaluation of several farms, and very distinct data has been obtained, depending upon the risk of the area. Efficiency data surpassing 90% have been observed in low-risk zones, while for the more vulnerable ones, values of less than 20% have been obtained. This means that in these latter cases, only 20% of the nitrogen contributed is consumed by the crop, while 80% is susceptible to being leached. The actual leaching will occur with rains or with high levels of irrigation, and can show up at a great distance from the farm, depending upon the various layers of the deep horizons. But what is clear is that regardless of when or where the contamination occurs, 80% of the nitrogen applied will at some time contribute to pollution.

This methodology also makes it possible to evaluate which factors are provoking the leaching, and as such also makes it possible to prescribe corrective measures, such as the selection of a more appropriate fertilization source, adjustment of the dose, frequency of the applications, or management of the associated irrigation.

As a real-life example of the methodology, an NLR-map (Nitrate Leaching Risk map) is shown, where 3 zones are located for evaluation. For the development of this map, the following was borne in mind:

- Physical properties of texture and content of organic material in terms of its effect on mobility of the nitrate and of water.
- Chemical properties related to the nitrogen content, and other nutrients or toxins that can have an influence on the plant's absorption efficiency.
- Orography of the terrain, reflecting accumulation processes.



Upon evaluating the following 2 points of the method during a one-month period, the chemical concentration observed in the lysimeters as compared to the one obtained from the fertilization plan established a percentage of efficiency for each zone and, as a result, provided an approximate value of the Kgs of potentially leachable nitrate for the period chosen.

Zone	Area (hectares)	Kg N/hectare andmonthcontributed	Kg N/hectare andmonth, PL*	Efficiency %
P1	5.9	12.4	5.3	56.7
P2	9.6	23.4	7.4	66
P3	14.3	11.4	0.5	95.3

*PL: approximate potentially leachable amount

It is obvious that in the zone with the least risk of leaching, the fertilization plan was most in keeping with the demand of the crop, and therefore the efficiency is very high. The opposite situation is seen in Zones 1 and 2, which have a high content of sand and a greater presence of salts.

It is seen that the greatest leaching occurred in Zones 1 and 2. This was due to the extra contribution of nitrogen to fight against the nitrate/chloride antagonism, along with the use of a greater volume of water to prevent accumulations of salts, which in a sandier environment provokes high nitrate mobilization. The corrective measures focused on reducing the dose of nitrogen, increasing the frequency of irrigation while reducing its total volume, and control of salt accumulationat specific points. This made it possible in just one month for the data to change in a favorable direction. Efficiency increased by an average of 20% for the zones of greatest risk, that is, Zones 1 and 2.

Zone	Area (hectares)	Kg N/hectare and month contributed	Kg N/hectare and month, PL*	Efficiency %
P1	5.9	10.5	3.4	68.2
P2	9.6	15.2	3.3	78
P3	14.3	10	0.4	96

*PL: potentially leachable

This methodology is thus shown to serve as a tool, with three uses of great importance:

1. On the one hand, it establishes a space-time evaluation criterion on nitrogen efficiency, and indirectly provides certain approximate values for potentially leachable nitrogen.
2. On the other hand, it contributes sufficient information to improve the data and start establishing strategies that will make it possible in the future to minimize contamination of the aquifers.
3. The greater efficiency of the applications also offers better profitability and sustainability for farmers who undertake this process, providing one more aspect of support for them, rather than a penalizing or restrictive measure.

Do not hesitate to contact our Agronomy department for more information here