Technological service platform

AGQ Labs is a chemical technological center, with over 20 years of experience, based on analysis laboratories, advanced assays and specialized chemical engineering. AGQ Labs provides solutions and services for agro-food, environmental, industrial and mining sectors. It is a synchronized process between technology and knowledge, between analytical chemistry and applied chemistry.

- Technological Center
- Control Laboratory
- Consulting / Specialized Engineering
- Inspection and Control
- Agronomy
- Food Safety
- Environmental control
- Mining
- Health & Safety
Global presence

- 25 branches
- 8 Labs
- +600 staff
- +500 k samples a year

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Qualification, Accreditations and Permits

AGQ Labs has the highest level of international accreditation that is available for assays laboratories. These accreditations, certifications and authorizations guarantee our developments and works in analysis and inspection.
Qualification, Accreditations and Permits

USA

Membership

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Agriculture was our origin. Most of our differentials have been developed in this area, such as Crop Nutritional Monitoring (patented).

We advise more than 3,800,000 acres worldwide.
Nitrates leaching in Europe

The Nitrates Directive (91/676/CEE) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices.

**Limits of pollution in groundwater**

- Nitrates < 50 mg/l (Nitrate Nitrogen < 11.3 mg/l)
- Pesticides and metabolites < 0.1 µg/l.
- Pesticides and metabolites (total sum) < 0.5 µg/l.
Nitrates leaching in Spain

The European Directive is transposed in 1997, after continued pressure from the European Union. It was the last country to comply with the guidelines of the Commission. Only Denmark met the deadlines.

In Spain there was always the debate that this directive did not take into account the Spanish conditions of recurrent drought and fruit and vegetable production (the biggest in Europe)

Limits for Nitrogen application (recommendation)

100 Kg per ha/year

50 Kg en vulnerable areas (Doñana, Daimiel)
Nitrates leaching in Andalucia

Vulnerable areas map

Decreto 36/2008 establishes measures against pollution by nitrates of agricultural origin. Includes training, dissemination, research and experimental development actions,

Limits for Nitrogen application

100 - 170 Kg per ha/year, depending on the crop and soil type

30-50 Kg en vulnerable areas

There is a table of nitrogen units per crop
WHAT AFFECTS NITRATE LEACHING

Regardless of where pollution appears, its origins are defined and concentrated in certain risk areas

1. Nitrogen input
2. Plant activity
3. Soil type
4. Nitrate and water movement

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HOW TO IDENTIFY RISK AREAS

**NLR-map**  (Nitrate Leaching Risk map)

With specific soil analysis and farm information we can develop a NLR map to identify where are the most risky zones

According to:
* Physical soil characteristics: Clays, silts, sands, bulk density
* Presence of nitrogen sources
* Organic matter
* Farm topography

These maps are also used to find out where to install soil solution probes to better understand the nitrate movement along the soil profile
Crop Nutritional Monitoring®

Evaluation of farm, plot and soils. Installation of probes for extraction of soil solution

1. Monitoring and control of crops under technified irrigation
2. Optimization of fertilizer usage and water requirements
3. Optimization of the leaching fraction (Minimize environmental impact)
Essential Mineral Nutrients

- Macro Elements: required in large amounts (80 – hundreds Lbs/acre)
- Secondary Elements: required in large amounts (20-80 Lbs/acre)
- Micro Elements: required in small quantities (a few or less Lbs/acre)
- Others in study/discussion: Nickel, Chlorine, Cobalt, Vanadium
# Mineral Nutrients

<table>
<thead>
<tr>
<th>Elements</th>
<th>Symbol</th>
<th>% Dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIDROGENO</td>
<td>H</td>
<td>6</td>
</tr>
<tr>
<td>CARBONO</td>
<td>C</td>
<td>45</td>
</tr>
<tr>
<td>OXIGENO</td>
<td>O</td>
<td>45</td>
</tr>
<tr>
<td>NITROGENO</td>
<td>N</td>
<td>1.5</td>
</tr>
<tr>
<td>POTASIO</td>
<td>K</td>
<td>1</td>
</tr>
<tr>
<td>CALCIO</td>
<td>Ca</td>
<td>0.5</td>
</tr>
<tr>
<td>MAGNESIO</td>
<td>Mg</td>
<td>0.2</td>
</tr>
<tr>
<td>FOSFORO</td>
<td>P</td>
<td>0.2</td>
</tr>
<tr>
<td>AZUFRE</td>
<td>S</td>
<td>0.1</td>
</tr>
<tr>
<td>CLORO</td>
<td>Cl</td>
<td>0.01</td>
</tr>
<tr>
<td>BORO</td>
<td>B</td>
<td>0.002</td>
</tr>
<tr>
<td>HIERRO</td>
<td>Fe</td>
<td>0.01</td>
</tr>
<tr>
<td>MANGANESO</td>
<td>Mn</td>
<td>0.005</td>
</tr>
<tr>
<td>CINC</td>
<td>Zn</td>
<td>0.002</td>
</tr>
<tr>
<td>COBRE</td>
<td>Cu</td>
<td>0.0006</td>
</tr>
<tr>
<td>MOLIBDENO</td>
<td>Mo</td>
<td>0.00001</td>
</tr>
</tbody>
</table>

**Macronutrientes**

**Micronutrientes**

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HOW TO EVALUATE EACH RISK AREA

With this soil solution probes we can evaluate everything related with nitrogen movement in depth.

Surface level. Input
Nitrogen forms
Plant activity
Nitrate movement and leaching
Evolution along the time
3D COMPLETE METHODOLOGY

X,Y
Spatial evaluation

Z. Understanding movement in depth

Time
Evolution along the time

This technology allows us not only to evaluate nitrate pollution, but also helps to develop good agricultural practice to minimize the risk, while keeping the crop in optimal and sustainable conditions.
# Report example

Strawberry – Oxnard data

<table>
<thead>
<tr>
<th>Water Samples</th>
<th>Sampling Date:</th>
<th>NO3(^{-} (\text{meq/l}))</th>
<th>Zn (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-nov</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFS</td>
<td></td>
<td>&lt;0,16</td>
<td>0,05</td>
</tr>
<tr>
<td>TUBE 20 cm</td>
<td></td>
<td>0,23</td>
<td>0,05</td>
</tr>
<tr>
<td>TUBE 40 cm</td>
<td></td>
<td>1,32</td>
<td>0,05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Samples</th>
<th>Sampling Date:</th>
<th>NO3(^{-} (\text{meq/l}))</th>
<th>Zn (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28-nov</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFS</td>
<td></td>
<td>13,7</td>
<td>0,33</td>
</tr>
<tr>
<td>TUBE 20 cm</td>
<td></td>
<td>2,14</td>
<td>0,15</td>
</tr>
<tr>
<td>TUBE 40 cm</td>
<td></td>
<td>2,88</td>
<td>0,30</td>
</tr>
</tbody>
</table>
Case Study

Modeling of leaching profile in agricultural farms

**Objectives**

Evaluate nitrates lost depth and propose corrective measures.

The efficiency objectives of nutrient absorption were situated in values close to 90%.
Location of control points. Defining control points

GIS maps to assess risk points
- Textural classification
- Chemical characteristics
Characterization of control points

Three probes will be installed at each point at depths of 20 cm, 40 cm and 60 cm. These probes will collect a sample of soil solution to which a complete physicochemical analysis will be performed with the following parameters. At the points of maximum risk of 100 cm probes will be installed.
Sampling 1. Control Point 1

<table>
<thead>
<tr>
<th>Site</th>
<th>Control Point 1</th>
<th>5,9 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Date</td>
<td>03/10/16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RFS</th>
<th>NO3-</th>
<th>NH4+</th>
<th>H3PO4-</th>
<th>Cl-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.2 meq/l</td>
<td>2.5 meq/lit</td>
<td>22 ppm</td>
<td>1.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>20 cm</th>
<th>NO3-</th>
<th>NH4+</th>
<th>H3PO4-</th>
<th>Cl-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.9 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>15 ppm</td>
<td>1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>40 cm</th>
<th>NO3-</th>
<th>NH4+</th>
<th>H3PO4-</th>
<th>Cl-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.8 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>15 ppm</td>
<td>1.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>60 cm</th>
<th>NO3-</th>
<th>NH4+</th>
<th>H3PO4-</th>
<th>Cl-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.4 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>10 ppm</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Total irrigation volume in this month in P1 area

Total Kg of N applied in this month in P1 area

Only the 60% of the irrigation volume is with fertilizers

Total Kg of N–NO3⁻ leached in this month in P1 area

Considering loss of 20% of the total irrigation volume

% of N–NO3⁻ leached in this month in P1 area
### Sampling 1. Control Point 2

<table>
<thead>
<tr>
<th>Site</th>
<th>Control Point 2</th>
<th>5,9 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Date</td>
<td>03/10/16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>NO₃⁻</th>
<th>NH₄⁺</th>
<th>H₃PO₄⁻</th>
<th>Cl⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFS</td>
<td>4.8 meq/lit</td>
<td>2.2 meq/lit</td>
<td>43.0 ppm</td>
<td>1.2</td>
</tr>
<tr>
<td>20 cm</td>
<td>6.7 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>32.0 ppm</td>
<td>1.5</td>
</tr>
<tr>
<td>40 cm</td>
<td>7.8 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>12.0 ppm</td>
<td>1.4</td>
</tr>
<tr>
<td>60 cm</td>
<td>9.5 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>4.0 ppm</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Total irrigation volume in this month in P2 area**

**Total Kg of N applied in this month in P2 area**

Only the 60% of the irrigation volume is with fertilizers

**Total Kg of N–NO₃⁻ leached in this month in P2 area**

Considering loss of 15% of the total irrigation volume

**% of N–NO₃⁻ leached in this month in P2 area**
### Sampling 1. Control Point 3

**Site**: Control Point 3  
**Sampling Date**: 03/10/16  
**Area**: 5.9 ha

<table>
<thead>
<tr>
<th>Depth</th>
<th>NO₃⁻</th>
<th>NH₄⁺</th>
<th>H₃PO₄⁻</th>
<th>Cl⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFS</td>
<td>2.3 meq/lit</td>
<td>1.1 meq/lit</td>
<td>32.0 ppm</td>
<td>1.2</td>
</tr>
<tr>
<td>20 cm</td>
<td>.7 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>12.0 ppm</td>
<td>1.5</td>
</tr>
<tr>
<td>40 cm</td>
<td>1.6 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>19.0 ppm</td>
<td>1.4</td>
</tr>
<tr>
<td>60 cm</td>
<td>1.9 meq/lit</td>
<td>&lt;0.16 meq/lit</td>
<td>10.2 ppm</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Total irrigation volume in this month in P3 area**: 

**Total Kg of N applied in this month in P3 area**: 

Only the 60% of the irrigation volume is with fertilizers

**Total Kg of N–NO₃⁻ leached in this month in P3 area**: 

Considering loss of 5% of the total irrigation volume

**% of N–NO₃⁻ leached in this month in P3 area**: 

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Corrective measures

During the next cycle, the following corrective and control measures are proposed:

1. Keep the size of the irrigation wetting pattern. So the moisture reaches the leaching point.
2. Control the fertilizer injection and the sources of them. At peak need, concentrate and maximize injection in the first 40 cm, where the active root are.

GOAL: to reach 90% of fertilization efficiency
Crops | Acres
---|---
Avocado | 11,624
Blackberry | 4,119
Blueberry | 565
Broccoli | 156,565
More veg | 109,051
Pepper | 6,637
More berries | 6,036
Spinach | 9,772
Strawberry | 58,902
Grape | 146,840

TOTAL | 510,111

**Improving fertilization efficiency**

If we improve the fertilization efficiency, the amount of the applied fertilizer can be reduced.

Reducing 5 lbs N/acre

\[
5 \text{ lbs/acre} \times 510,111 \text{ acres} = 2.5 \text{ Million lbs N}
\]

Reducing 10 lbs N/acre

\[
10 \text{ lbs/acre} \times 510,111 \text{ acres} = 5 \text{ Million lbs N}
\]
Things to remember

* Crop Nutritional Monitoring goals are:
  - Monitoring and control of crops under technified irrigation
  - Optimization of fertilizer usage and water requirements
  - Optimization of the leaching fraction (Minimize environmental impact)

  • Improve the final product quality
  • Increase yield (lbs/acre)
  • Be more efficient with the fertilizer injections (lbs N/acre)
  • Reduce the Nitrates leaching