FERTIRRIGATION
WITH AIR

NABB RE LIFE (Nano Air Bubble System)

Following the experiences gained in the creation of water-fuel emulsifiers WiFNE (Water in Fuel Nano Emulsion) we have created an industrial generator of nano bubbles of any gas or air in water, which, from analyzes performed with the coulter, resulted to have the following dimensions:

- Average particle size from 200 to 500 nm
- Maximum size 500 nm
- Percentage of particles < 500 nm = 80%

allowing flow rates of even a few tens of mc/h, where at least 15% - 20% is gas.

Nano bubbles have some important peculiar properties:

- they are negatively charged (zeta potential) which keeps them separate;
- are subject to Brownian Movements;
- have a very small surface area (300 - 500 nm)
- with respect to the volume of gas contained;
- have a very high internal pressure of about 30 bar;
- they have a great solubility of the contained gases, favored by the greater internal pressure which facilitates their dissolution in the receiving body, making them immediately available.

Thanks to this, it is possible to make available quantities of oxygen, present in the air, higher than the natural saturation which dissolve in the receiving body, the water, guaranteeing both an environment suitable for the development and work of aerobic bacteria which are more active and odorless of anaerobics.

The nano bubbles do not rise to the surface and dissolve in the water only within the limits of the maximum saturation possible under the given conditions, thus remaining in the liquid for a prolonged period, even a few weeks.
Obviously, in situations of strong bacterial activity, dissolved oxygen is used by progressively reducing the saturation which the nano bubbles reintegrate thanks to the high pressure and contact surface, restoring the optimal situation.

In the process we also have a minimal production of micro and Milli-bubbles which slowly rise to the surface, and if required they can be eliminated by stripping using a nano bubble concentrator.

Measurement
The only way to ascertain the presence of nano bubbles is to use the specific tool.
In a liquid environment, the presence and measurement of dissolved oxygen is given only by the microbubbles, millibubbles and nanobubbles that have opened, but it is absolutely not possible to attribute the value found to the nanobubbles produced as they are still closed, and the oxygen inside is undetectable. So for high dissolved Oxygen values it means that the generator produces a large part of larger bubbles which open immediately, oxygenating the water.

USE IN THE AGRICULTURAL SECTOR - FERTIGATION

Since the mid-twentieth century, increasing quantities of chemical fertilizers and pesticides have been used to increase the yield of agricultural crops, generating an ever greater deterioration of soil characteristics. In fact, a vicious circle has been triggered where the necessary increase in chemical products, in addition to generating a considerable environmental impact due to normal soil washout and percolation, also generates an ever greater impoverishment of the soils.
Modern intensive agricultural practices using hybrids and high-yielding varieties are rich in fertilizers, require high water consumption, reduce the naturally existing microbial mass that plays the important role of maintaining soil health and supplying the necessary nutrients to plants.

To overcome these drawbacks, science at the service of farmers has begun to study bacterial compounds capable of limiting the use and damage of chemical products.
Applied Biotechnology is a concept of sustainable agriculture that has a primary emphasis on the manipulation and management of biological systems to maximize yields, stabilize agro-systems and minimize demands for chemicals. This results in an integrated approach of modern technology with traditional techniques.

For this purpose AVKEM has created the NabReLife System, - Fertigation obtained by enriching the water with nano air bubbles (containing 19% of O2, 78% of N2) making them immediately available to the fixing and user bacteria, which, by increasing the 'root system allow the reduction of water demand from 5% to 10%, producing different results, such as:

- Making nutrients blocked in the soil more available
- Repopulation of the bacterial flora of the soil and finding of greater reactivity with an increase in the root system and a decrease in water demand
- Reduction of nutrients to be introduced into the soil

obtaining healthier plants, better yields, with a consequent reduction in management costs and environmental impact.

The system allows you to insert up to 15% - 20% of air into the water flow, with a large availability of O2.
The table below indicates the quantity of O2 transferred to the ground as a function of the water flow rates

FLOW RATE	**AIR**		**O2**		
cm/h	**%**	**cm/h**	**%**	**cm/h**	Kg/h
0,5 1	12 %				
1 3	13 %				
6	15 %	0,90	19 %	0,171	0,23
10	18 %	1,80	19 %	0,342	0,45
15	22 %	3,30	19 %	0,627	0,83
30	25 %	7,50	19 %	1,425	1,90

ADVANTAGES OF GREATER OXYGENATION OF THE SOIL AND PLANTS

One of the primary conditions for plant development is soil aeration because it is directly involved in the development of the root system which guarantees healthy vegetation with high yields.

Plant roots require atmospheric oxygen to breathe and release energy for their needs from glycolysis. In poorly ventilated soils, the roots, essential for absorbing nutrients and water, are poor in oxygen and therefore unhealthy. In addition, soil aeration is necessary for aerobic microorganisms, necessary for the oxidation of the organic matter present and added to the soil.

Aeration has significant effects on the supply of nutrients such as **Nitrogen**. In fact, poor ventilation induces a shift of nitrates towards nitrous oxide (N2O), a greenhouse gas whose production must be avoided. Furthermore, the denitrifying bacteria which are facultative aerobic bacteria in poorly oxygenated soils with a low concentration of O2 could pass to the anaerobic respiration of NO3 and NO2 with the consequent deprivation of vegetable nitrates.
In relation to **Manganese and Iron**, the two micronutrients have high value in well-aerated soils and low value in poorly aerated ones. Although plants can only absorb and use low valence forms, their excessive absorption is detrimental to crops. For this reason, excessive access to low-valence forms of micronutrients must be limited.
Last, but not least, **Sulfur**, which is assimilated as sulphate by plants in airy soils. In poor aeration conditions, the sulphate turns into sulphide and the hydrogen sulphide is toxic to organisms.

Nutrient imbalance causes root formation to deviate, which will inevitably affect the growth of the entire plant and cause yield losses.
In this context it should be remembered that soil aeration could be a strategy to counteract the increase in **salinity** of irrigated water, in fact the negative effect of NaCl stress can be compensated by soil aeration. Soil aeration can promote root growth and increase photosynthetic rate and chlorophyll content, thus promoting plant growth and reducing plant death rate under NaCl stress conditions.
Furthermore, soil aeration has an indirect effect on reducing **deep percolation**. Soil aeration helps improve root growth and spread, thereby increasing the plant's ability to benefit from irrigation water, reducing the amount of water lost due to deep percolation, thus further improving productivity and generating savings of water.

NITROGEN FIXATION

Nitrogen cannot be assimilated by the ground in the form of N2, but only in the form of Nitrites - Nitrates and other compounds, therefore for the moment it should not be taken into consideration.
Studies are underway to understand how it can be combined and transformed to make it assimilable or how to increase it in animal manure used as fertilizer.

IRON BACTERIA AND HARMFUL ORGANISMS

Ferrobacteria (iron fixing bacteria) present in irrigation water can cause many problems, including a bluish film on plant surfaces and brown spots on leaves, both of which are related to the high iron content of the water. These are normally found in the ground but can be a problem, in wells (blocking submersible pumps) and in irrigation basins (generating an oily film on the surface of the water). These keep the iron suspended in the water, preventing it from settling, so when the irrigation ends up above the plants, the bluish deposit of iron forms. Furthermore, in the propagation greenhouses, a yellowish, viscous mucilage can be observed which clogs the nozzles, caused by iron bacteria.

The use of our nano bubble generator, thanks to the mechanical action, allows to exterminate the bacterial load present in the irrigation water taken from wells and basins, as the dimensions of the bacteria are greater than the nanometric dimensions, which are therefore literally shredded. In this case, the massive use of bactericidal and detergent compounds, harmful to plants, is also avoided. In the accumulation basins of the irrigation water there will also be a significant reduction until the disappearance of the eutrophic phenomena with the proliferation of unicellular algae, responsible for the phenomena of anoxia in the water, and a consequent increase in the O2 values.