## *Getting more bang from your nitrogen investment.*

If you cut your nitrogen by 80% tomorrow, would you expect your production to drop?
Of course it would… if you did nothing else. Optimising nitrogen use is one of the holy grails in a drive to produce food for a booming world population, all whilst looking after the environment.

Under the radar a growing number of farmers are successfully dropping their N to astoundingly low levels in an approach that provides a wide range of benefits. To support farmers findings, BioAg conducted a series of US based replicated crop trials. Reducing N by 15%, BioAg's liquid product range provided a staggering 26% yield increase above standard fertiliser practices. How is it that biological farmers can dramatically reduce nitrogen without reducing production?

The journey starts with an appreciation of soil health's role in driving the nitrogen cycle.

## *Soil Structure*

Despite common perceptions, your number one yield limiting factor is not nitrogen, its air. Improving yield starts with a soil that can breathe.

Without adequate airflow, roots and microbes curl up and die. Natural mineral and water cycles also breakdown. Compacted and waterlogged soils lose valuable nutrients including N[i], and reduce those microbes responsible for providing N to your crops.

Air, and water, moves into soil through the gaps in soil aggregates; the crumbs formed by soil microbes. Just like constructing an apartment building, microbes and earthworms make hallways, stairwells and living spaces. Poor soil structure turns these apartments into a tarmac. This loss of structure stalls the natural nitrogen cycle.

The recent State of the Environment report shows that 78% of dairy farms were badly affected by compaction in 2013. This is a double whammy for farmers and the environment, as compacted soils require more N and lose more N into the atmosphere and waterways[ii iii]. Research shows, that depending on the type of N used, up to ten times more N is lost from compacted soils[iv]; requiring more inputs to maintain production.[v]

Often when considering natural nitrogen inputs, farmers most often think of legumes, particularly clover and rhizobia for N fixation. However, in healthy soils among the most common organisms are free-living bacteria which fix nitrogen into the soil. These free-living N fixers require air, so compacted soils will have less of these important organisms.

The high use of soluble nitrogen creates a vicious cycle; putting farmers on a treadmill of decreasing returns due to the breakdown of soil carbon, thus a loss of humus and an increase of microbes which love to feed on N. The loss of carbon creates the conditions for compaction, increasing runoff and erosion and limiting root growth. Just too really put the boot in, these soils then require more irrigation, creating more vulnerable farm systems.[vi]

### *How efficient is your N fertiliser?*

Our modern farming practices are leaky and inefficient. In dairy systems only 15-35% of the N applied is actually made available to the plant, with the majority of applied N lost to the air and waterways (globally this figure is 5-15%)[vii]. There wouldn't be many businesses happy with those kinds of inefficiencies, particularly for something which may be such a major input. So why do we tolerate it in farming?

Increasingly fertiliser companies are focussing on add-on products to improve N efficiencies, like DCD, Nitrapyrin and Agrotain. Even projections for best practices around nitrogen, the soundest estimates offer 60% efficiency at best. These products will enable fertiliser companies to continue business as usual, without addressing the key issue; why do you need to add soluble N, and why is the nitrogen cycle not working optimally?

There is 78,000 kg/N above each Ha of land. The availability of nitrogen for the plants is determined by:

- The activity of soil microbes which release plant available N
- The amount and type of food for microbes
- Plant diversity; deep roots and legumes
- Grazing efficiencies and manure additions.
- Soil organic matter levels and humus development

Additional disruption to natural N function has been introduced with chemical pasture topping and herbicide brown out practices using glyphosate, which has an inhibiting effect on N fixation and promotes N oxidisers[viii].

The success of Biological Agriculture begins through building a foundation to enhance natural cycles, using proactive practices which address the root causes, versus reacting to symptoms. Fostering underground livestock is an essential ingredient to reducing N inputs. One key in profitably reducing N, is through the addition of carbon based biological foods and stimulants to improve soil structure and nitrogen storage[ix] while maintaining yields [x] [xi].

The availability or loss of nitrogen can be impacted naturally by;

- Temporary storage in clay humus complexes (**adsorption**)
- Being built into other soil life (**immobilisation**)
- Humus production (**humification**)
- Losses below the root zone due to **leaching in low CEC soils and/or high rainfall**
- Lost into the atmosphere through **volatilization** as nitrogen gas

Plants require nitrogen in different forms throughout the growing season; applying large volumes of N at once is ineffective in supporting plants through the year. Biological production creates significantly less emissions and leaching[xii] [xiii], while providing nitrogen in plant available forms when plants need it[xiv].

## *Microbiology and Soluble N*

Many plant species are completely dependent on microbial partners for growth and survival.[xv] High inputs of soluble N fertilisers dramatically change microbial communities; reducing organic N and C, microbial diversity and overstimulating bacteria.

Fungi to Bacteria (F:B) ratios are important for soil structure and pasture health. New research has also shown that soils higher in fungi reduce N leaching[xvi] [xvii]. Mycorrhizae, a plant symbiotic fungus, have been shown to reduce leaching by 40%.[xviii] These important fungi also produce a substance called glomalin, a relatively stable soil protein important in soil structure. [xix] Degrading soil health and the addition of soluble N reduces the F:B ratio, creating more bacterial soils with time.

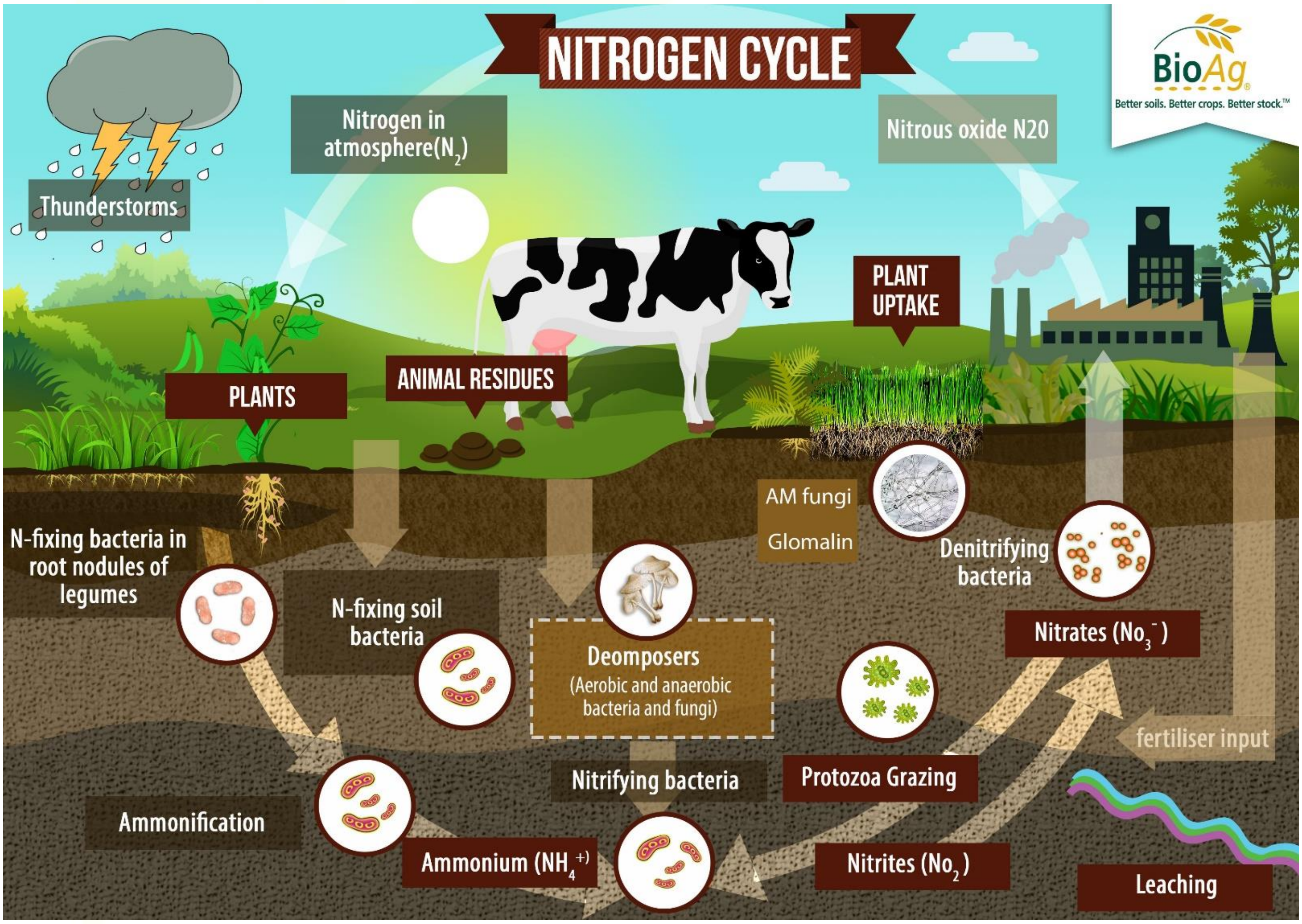
During the life and death processes which drive healthy biological systems, nitrogen goes through a variety of forms before being taken up by plant roots. Bacteria consume N and hold it in their bodies. If the soil foodweb has been compromised, through compaction or high soluble N applications, there is often lower predation from protozoa and nematodes[xx]. This means N becomes immobilised or bound in the soil, unavailable to plants.

Not all synthetic N is detrimental, adding small amounts of N (5 units/Ha) has actually been found to be beneficial for soil microbiology, acting as a catalyst to help stimulate the natural N cycle.

Research is showing that high yields can be maintained and inputs reduced through good management of soil, water, energy and biological resources. A replicated BioAg rice trial in 2015 conducted by Rice Research Australia produced the same yield, with significant savings, using 150 units (326kg Urea) less than the control. Other international studies have shown that the same corn yields were possible by reducing chemical inputs by half and cutting a third of costs.[xxi] [xxii]

## *Feed your soil*

Soils are an ecosystem; supporting and feeding soil microbes have huge benefits across the entire farm enterprise. Reducing nitrogen can be profitably and sensibly done through enhancing microbiology and soil health resulting in huge leaps forward for the environment and farming bottom lines.




*Nitrogen Cycle including biological processes* ©BioAg Ltd

## *Humus and humification*

The living conditions for a healthy soil food web require; good soil structure, water retention, drainage, aeration, warmth, low toxicities and pH (from cation balance). Bringing all of these conditions together creates optimal humification and mineralisation rates**.**

If humus levels reduce so will the diversity and amount of micro-organisms that provide plant nutrients and feed the humification process. This reduction in plant food supply will result in a downward spiral first affecting plant health, then animal health and produce quality. Generally this downward spiral is masked by increasing amounts of fertiliser inputs to secure production levels and agri-chemicals to treat symptoms.

**Humification** – the building and maintenance of soil where soil biology (ecology) processes plant (and animal) matter into humus.
This process creates the structure for air, water, micro-organisms and nutrient storage. Nutrient availability - some nutrients are made available by micro-organisms decomposing humus (1-5%).
Humus (humification) is also where other metabolic substances are created and stored e.g. enzymes, secondary metabolites, vitamins, natural growth hormones.
**Mineralisation** – is the delivery mechanism of nutrients from soil and soil organic matter. Primarily driven by biological activity (micro-organisms) creating plant available forms but also involves chemical and weathering mineralisation.

**Organic matter mineralisation rates:**

1. Fresh organic matter – 50 to 70% per year
2. *Dynamic (active) organic matter – 30 to 50% per year
3. Humus – 1 to 5% per year

*Dynamic or Active organic matter is the transition phase where the parent material is no longer recognisable

Source: Frank van Steensel (M.Ag.Sc)

"All farming involves the management of an ecosystem"

Professor Emeritus Don M. Huber, Purdue University

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