Chasing the Biggest Bang:
Ten Tips for Farmers/Gardeners to Reduce Input Costs

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Most of the many growers I work with around the world are reeling at the rising cost of fertilisers and farm chemicals. Urea is at record prices, the DAP/MAP duo[1] have doubled in cost and potassium prices are increasing by the month. It is hard to see how conventional agriculture can remain viable, unless there is a dramatic rise in food prices.

The good news is that it is now prime time for a wake-up call. It's time to consider fertiliser efficiency, to review mineral requirements, and to optimise all inputs. It may also be time to recognise the role of soil life in your profitability equation and to utilise this hidden workforce more effectively.

So, let's begin with the big three, as it is the NPK price hikes, and shortages, that have recently rocked the world of so many of my fellow farmers.

Let's start with nitrogen. This major mineral is the most mismanaged of all and there can be considerable gains in improving your nitrogen management.

Nitrogen abuse and misuse - Discover the N game changers.

Agriculture is responsible for **80%** of the nitrous oxide emissions that thicken the gas blanket that is heating and radically changing our world. Obviously, we must be mismanaging that mineral because that 80% reflects massive N losses that should be either contributing to crop yields, or in our back pockets.[i]

There are **five** key ways we can improve nitrogen management and reduce nitrogen input costs. These include:

1) **Stabilising all N inputs** - most applied nitrogen is converted to the highly leachable nitrate anion, that can only be stored on the humus colloid. Humus has been 2/3 depleted in our soils over recent decades. That carbon loss has actually been fast-tracked by mismanaged nitrogen. It is now understood that for every kilogram of N that is applied over and above the immediate requirements of the plant, there is an associated loss of **100 kg** of carbon to the atmosphere.

How can we change that destructive abuse? Firstly, we realise that large amounts of nitrogen at planting are counterproductive. What tiny seedling requires a big N kick? This is the perfect recipe for burning precious soil carbon, with potential losses at that 1:100 ratio. Secondly, we should always stabilise starter N with **humic acid**. The inclusion of **5%** Soluble Humate Granules with ammonium N or nitrate N fertilisers creates a non-leachable N supply that is also less prone to volatisation (losses to the atmosphere); i.e ammonium humates and urea humates cannot leach or volatise.[ii]

2) **Foliar spraying of urea** - this is probably the single most important N efficiency strategy. Urea begins life as something called an **amine**. When urea is applied to the soil, the urease enzyme converts it from the amine form into ammonium nitrogen. Shortly thereafter, microbes convert it to

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[1] MAP and DAP are ammonium phosphate fertilisers, MAP having 10% nitrogen and DAP 18%.

"DAP is the most economical, and therefore the world's most commonly traded and used phosphorus fertiliser. Its high analysis minimises freight, handling and storage. It is used both on its own and in combination with other fertilisers in blends. Both DAP and MAP are compatible in blends with urea, the world's most commonly used nitrogen fertiliser, whereas superphosphate is not." https://www.incitecpivotfertilisers.com.au/

nitrate nitrogen, which is always carried into the plant with water. This water carrier dilutes nutrient density within the plant and creates a calling card for insects. Most of you may have probably noticed an increase in pest pressure following a urea application.

The nitrate nitrogen is now stored in the leaf awaiting conversion to protein. This conversion process involves three steps, but the first of these steps is hugely energy intensive. That first, energy-sucking step involves the conversion of nitrates to the amine form. Then, it is a simple and rapid process for amines to become amino acids, and then protein.

What would happen if you bypassed this tortuous process and foliar sprayed urea directly on to the leaf. Well, foliar fertilising is 12 times more effective than soil fertilising so that represents obvious potential for savings. However, with this strategy the amine is simply and rapidly converted to protein, with very little energy expenditure. A foliar spray of **12 kg** of urea per hectare to a broadacre crop can be equivalent to a side dress of six times that amount and there is no leaching, no volatilisation and **rapid protein formation.** It is important to recognise that plant immunity is protein-based. Higher protein is not just higher premiums. It also equates to less pest pressure.

There is one important tip to maximise this particular strategy. Always combine the foliar urea with **humic acid**. When humic acid and urea are combined, a stable **urea humate** is created. The humic also buffers any potential burn, while also increasing N uptake by 30%. Humic acid is also a plant growth stimulant in its own right, so it is a nice outcome. It can also be an inexpensive inclusion if you make your own humic acid.. That's as simple as dissolving Soluble Humate Granules at the rate of 1 kg per ten litres of water in a 1000 litre shuttle. That is, 100 kg per 1000 litres. The end product costs about **30 cents** per litre and that DIY humic acid is combined with foliar urea at the rate of seven litres per hectare (at a cost of just **$2** per hectare).[iii]

3) **Growing our own nitrogen** - a legume-based green manure crop can provide the equivalent of 200 kg of urea to the subsequent crop. Even young cereals contain a good component of N if turned in before flowering. The term, "turned in" may not resonate with the no-till brethren, but the reality is that **minimum-till** is sometimes more productive. It is so counterproductive to burn off a cover crop with a herbicide because you believe no-till is the only way. The three nutrients that cycle as gases (carbon, nitrogen and sulphur) are all lost to the atmosphere when we resort to herbicides. It is vastly preferable to lightly turn a cover crop into the A horizon (the top 3 or 4 inches), to provide the soil-to-plant contact that fast-tracks the breakdown and utilisation of the full mineral and carbon lode in the cover crop.

4) **Inoculating nitrogen-fixing organisms** - the equivalent of 5000 truckloads of urea hovers above every hectare and you were supposed to harvest your share of this free gift. There are two equally important pathways to allow easy access to this 74,000 tonnes of gaseous N.

The first involves rhizobium, the nitrogen-fixing bacteria that live in the nodules attached to the roots of all legumes. It is not sufficient to inoculate legume seed with these organisms. There are three minerals that must be present to ensure that they form the nodules at the outset, and that they are able to actually fix nitrogen. Unfortunately, these are the minerals most missing in most broad-acre soils. **Sulphur** is the mineral that determines good nodulation, and a combination of sulphur, boron and molybdenum determines whether you are actually fixing N with your legumes. A **shovel** is an integral requirement for the Nutrition Farmer. Dig up some clover, peas or beans and check the nodulation. Then you need to take your pocket knife and slice open some of these nodules. If they are not pinkish red inside, then you are not fixing nitrogen. It's as simple as that, and I find that more than 50% of the paddocks I walk contain legumes that are not performing this critical role. 80% of the soils we check across the globe are deficient in molybdenum; and sulphur and boron are often neglected in broadacre scenarios. Foliar sprays and seed dressings can help address these shortages, **50 grams** of sodium molybdate and **I kg** of Solubor is generally sufficient to fire up fixation.[iv] (4)

The second pathway to the "free gift" involves inoculums of **free living nitrogen-fixing organisms.** One of my favorites is an Nutri-Tech Solutions product called **Bio-Plex**. This is a blend of specialist azotobacter that dwell on the leaf surface and fix nitrogen from the atmosphere, directly into the leaf, in the ammonium form. This is particularly productive because it helps ensure that the plant has the required 3:1 ammonium to nitrate ratio. This is an important resilience ratio often ignored by conventional agronomists. This strategy is quite cost-effective, particularly considering the exorbitant N prices. You are only using 125 ml of this powerful concentrate per hectare at a cost of less than $8.

There are also azotobacter inoculums (**Bio N**) that can be applied as a seed dressing, or via liquid inject at planting. You need to see an N-hungry maize crop with, and without, **Bio N**. You will then understand the potential of nitrogen-fixing inoculums!

5) **Improving nitrogen recycling** - Protozoa are key creatures responsible for recycling N from the nitrogen-packed bodies of the bacteria they consume. Bacteria have a 5:1 carbon to nitrogen ratio, which means that around 17% of their tiny bodies are made up of nitrogen. Protozoa have a 30:1 carbon to nitrogen ratio. A watermelon-sized protozoa consumes 10,000 bacteria a day. They effectively need to eat 6 bacteria, at 5:1, to realise their ongoing carbon requirements. However, they need only one of those six nitrogen units to satisfy their N needs. Hence they spit out five molecules of that unwanted N into the soil, and the plant says “you beauty”. If a protozoa, consuming 10,000 bacteria each day, spits out five molecules of N per bacteria, that equates to 50,000 recycled N molecules from just one protozoa. Pack your soil with protozoa and there is some serious N recycling.

Protozoa are lacking in most broadacre soils, but there are often huge numbers of bacteria present. What you need is a strategy to release this N lode for your crop, to reduce your need for applied N. That involves the creation of a very simple brew called a **protozoa tea.** Here’s how you can do this. You will need an aerated compost tea brewer, but this need not be a high cost item. We have 1000-litre brew kits for a few hundred dollars.

In a 1000-litre tank you need to add up to a full bale of **lucerne hay**, that has been fully broken up. Lucerne hay, as long as it has not been sprayed for Lucerne Flea, is jam-packed with protozoa chasing the high protein. Your brewer must involve bubbling, rather than a pump with venturis, or the lucerne hay will damage the pump. The microbe brewer containing the lucerne bale is filled with water, before the addition of ten litres of **liquid fish** and ten litres of **molasses**. The brew is then left to bubble for a minimum of two days. Then your tea is complete. If you have a microscope you will see the protozoa packed in like sardines, ready to cycle the nitrogen from your bacteria overload, and reduce your N costs. Protozoa also stimulate **root growth** so a good protozoa tea provides it a great win/win outcome.[v]

Reducing P inputs

Phosphate has doubled in price in many regions and China, the world’s largest exporter of DAP and MAP, has recently suspended phosphate exports. We are set for major dramas with supply of these inputs. In this context, it is critically important that we better understand **phosphate management** and utilisation.

There are five key considerations here and they include: stabilisation of the most unstable of minerals; increasing uptake of applied P; release of locked-up phosphorus; consideration of alternative P inputs; and the introduction of phosphate solubilising bacteria.

We are accessing only 27% of applied phosphate due to the triple negatively charged nature of this mineral. DAP and MAP begin to lock up in the soil within 24 hours of application and within 6 weeks most of the soluble phosphorus has become an insoluble component of a massive frozen P reserve. The good news is that this reserve can be seen as a treasure chest that can often provide your P requirements for seasons to come. It is always a good idea to conduct a total P test to determine the size of your personal, frozen reserve.

The very best trick to **stabilise P,** and reduce this lock up, involves the inclusion of **5%** Soluble Humate Granules with your granular P fertilisers; i.e. 5 kg per 100 kg. The soluble humic acid granules dissolve at the same rate as the DAP/MAP, and a stable **phosphate humate** is formed. You will now have phosphate for the full season, instead of the first 6 weeks.[vi]

However, this is just one of the benefits of the humic addition. The acid phosphate inputs are seriously harsh on **mycorrhizal fungi** in the soil, but the humic acid buffers the burn while stimulating all fungi, including AMF (arbuscular mycorrhizal fungi). The humic acid also promotes root growth and improves soil structure.

Humic acid also drives a well-researched phenomenon called '**cell sensitisation'** where the cell membrane becomes more permeable and capable of absorbing 30% to 34% more P. The cost of the **5%** humic acid inclusion can be **free,** in light of this finding. Due to this one-third improvement in P uptake, there is risk in reducing your P fertilisers by a few kg to cover the cost of the humates.

The third consideration to reduce P inputs involves tricks to promote the **release** of your locked up reserve. **Legumes** exude acids that can release locked up P. The inclusion of clovers beneath a cereal crop can provide both N and P to the host crop while also supplying some calcium.

Seed treatment with **mycorrhizal fungi** can cost less than **$10** per hectare. These organisms are famous for their ability to access phosphorus in the soil. Their massive root extension of tiny filaments allows far greater access to the most immobile of all minerals. This 1000% increase in root surface area can scavenge P over a much greater distance, while also releasing acids to break the bond between phosphate and calcium.

Fulvic acid is a well-researched P solubiliser, so it can be included in liquid inject programs at planting to free up some of your reserves.

The fourth P strategy involves exploring **alternative sources.** My favourite is **chicken manure.** In our region it can still be sourced for $20 per metre, delivered. If you just look at the 2% P content, this equates to 20 kgs of pure phosphate, or the equivalent of almost 100 kg of DAP. Just looking at P, the chicken manure is 5 times cheaper than DAP per unit of P, but it also contains good levels of N, K, Ca and sulphur along with trace minerals, carbon and microbes. This $20 bargain is actually worth well over $200.

Finally, we need to consider **plant growth-promoting bacteria (PGPB**). There are several super-productive bacillus strains, all of which can solubilise locked up phosphorus. *Bacillus megaterium* is the big specialist in this role, but *Bacillus subtilis*, *Bacillus amyloliquefaciens*, *Bacillus pumilis*, and *Bacillus licheniformis* can all access your P reserves while also offering many other benefits. Four of these imports can also fix nitrogen and one of them solubilises potassium. They can control multiple diseases including seedling diseases like Pythium, and they boost plant immunity and yield through the production of multiple plant-growth stimulants. The Nuntri-Tech Solutions product, **Micro-Force** features all five of these remarkable workhorses, in a freeze-dried form. This inoculum can be brewed and applied as liquid inject, a seed treatment or as a foliar for a few dollars per hectare.

There is some compelling new research suggesting that a combination of **silica, AMF and PGPB** can be super productive in terms of increased delivery of phosphate to the plant.[vii]

Efficient K management.

I call potassium '**the money mineral'** because it governs the size and weight of all crops. It is amongst the most expensive of major minerals and destined to rise substantially in price. Potassium is often a victim of our notorious nitrogen mismanagement because potassium is the first mineral shut down when we over-apply N. However, there is another excess that is rearing its ugly head in stressed farming soils across the globe. **Sodium** is building in many soils due to increasing salinity issues and drought. Sodium is super antagonistic toward potassium. High magnesium soils also antagonist to K uptake so it is common to see potassium shortages in broadacre soils.[viii]

The key to management of this mineral is **monitoring**. A potassium meter is an invaluable aid. Potassium is the most mobile of all minerals. When a shortage arises, the mineral will be sucked from the lower leaves to satisfy requirements at the top end of town (seed sizing and growing tips). If you are using tissue testing to monitor K, it is common that you will not pick up the problem until the entire plant is drained. At that point, you try to play catch-up, but there will always be some yield losses.

There is a trick that provides fingertip control of the **money mineral.** That tip involves testing the first, fully developed leaf at the top of the plant and then testing a leaf at the bottom of the plant. If potassium is well supplied, the levels should be similar. The moment the levels in the lower leaves have dropped 10% or more below the levels in the top leaves, you have a potassium deficiency, and you need to act immediately.

When monitoring in this manner, you will soon discover how much potassium is required after flowering, when the potassium drawdown is dramatic. Most of us miss this post-flowering K shortage and, consequently, yield potential is rarely realised.

The most cost effective potassium supply, to address an induced or an actual K deficiency, is the **foliar** route.[ix]

The best choice is to foliar spray **8 kg** of **potassium sulphate** per hectare in a minimum 100 litres of water with 250 grams of Soluble Fulvic Acid powder. This provides a substantial K-kick, while also supplying much needed sulphur, to boost protein levels. This tip is particularly important for a dry finish, because potassium is only sourced through soil solution, and there is no solution in parched soil. You will note the burned leaf margins on the lower foliage, as evidence of potassium vacating lower leaves to satisfy the shortage up the top of the plant, due to the dry conditions.

Reducing chemical requirements

Glyphosate is part and parcel of no-till agriculture, but that may not be the case in the near future, due to our greater understanding of the toxicity of this input. In the meantime, it is a productive strategy to reduce glyphosate requirements and to speed its breakdown in the soil. Here's how you can do this.

Fulvic acid has a **cation exchange capacity** of **1400,** which means it can take on board chemicals like glyphosate. This bonding can be beneficial. Fulvic acid also generates cell sensitisation, where increased membrane permeability facilitates at least 30% better plant uptake. In this context, the inclusion of fulvic acid with glyphosate means you can effectively reduce glyphosate inputs by 30% and still achieve the same kill. That is a good outcome, but there is a more important advantage relative to the breakdown of glyphosate. Bacteria are the creatures responsible for glyphosate breakdown and their favorite food is fulvic acid. They are drawn like bees to a honey pot to the glyphosate imbedded in the fulvic and this fast tracks the breakdown of the chemical. Fulvic acid is typically used as **Soluble Fulvic Acid Powder** at the rate of **120 gram** per hectare.

There is a second strategy that can help reduce glyphosate requirements. All chemicals have a pH sweet spot in which they operate most efficiently. Unfortunately, this information is not provided on the label, and you do not have to be too cynical to recognise the reason for this emission.

Most people know to drop the pH below 5 for glyphosate and often ammonium sulphate is used as an acidifier. However, it is now understood that the sweet spot for glyphosate is actually **2.9**.

In recognition of this link between pH and chemical efficiency, every farm shed should house a few bags of citric acid. This natural acid is very effective in lowering pH. As a rule of thumb, 100 grams of citric acid will drop pH by one full pH point. If the starting pH in your diluted glyphosate is 6, for example, then you would need a little more than 300 grams of citric acid per hundred litres, to arrive at the “ideal” of **2.9.**

We have many growers across the globe whom have combined fulvic acid and citric acid with glyphosate to rescue herbicide requirements by **50%.**

The pH-related difference in performance can be quite profound. If we look at **Diathane**, the world’s most popular fungicide, for example, we discover that Diathane at pH 7 has a half-life of just 18 hours. However, if you adjust the pH down to the sweet spot of pH **5.2**, this chemical suddenly has a half-life of 18 days.[x] (10)

Independent research from the US has identified the sweet spot for a wide range of farm chemicals.

In conclusion……

The positive side of this cost increase crisis in agriculture may be that it motivates many growers to explore **regenerative options**. In the process, farmers may discover tools that they never knew existed. They will improve efficiency, reduce input costs and become more sustainable, while increasing soil fertility and profitability. It may yet prove to be the dawn of a golden era in agriculture.

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