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This is an extract of the October 2007 Agronomic Acumen newsletter. You can see more newsletter examples from our website at www.agronomy.com.au/Newsletters.htm and other articles at www.agronomy.com.au.

Setting up a liquid cart

I believe you should have a liquid cart system with your seeder. Most people need one or more trace elements added to their paddocks, and using a liquid cart is the cheapest and most efficient means of giving it to the plant. I am so impressed with the results with my clients that I strongly encourage you to get one fitted to your seeder before next season.

But, what to fit, how to do it, what are the pitfalls etc…? I am not *au fait* with all the equipment and options, so I thought it would be best to ask a few farmers what they have tried and will change in regards to their experiences fitting a liquid cart to their seeder. I have also asked one of the main suppliers of this equipment for his views and suggestions. I hope you find the following of great value.

RYANAG's Fluid injection system
"Clontarf"
Yarrawonga, Victoria
Australia
Phone (03) 5744 3661 or 0428 298 031

L-R: Evan, Helene and John Ryan.

History

It made intuitive sense that we would be running short of critically important factors in our nutrition at some stage as we were not replenishing these through our traditional fertilisers (MAP, DAP, Gypsum, Lime and Super Phosphate).

This topic had fascinated me throughout my high school agricultural studies and further intensified after studying plant nutrition at university. It was Wayne Smith who really gave us the confidence to trial micronutrient nutrition application by providing us with guidance as to which products to use and their preliminary rates of application.

Above: 2 inch Cam lock fill point with taps to fill either main or flushing tank.

Below: From L-R Raven flow control valve, flow meter and 100mesh spray filter pump outlet, bypass tap.

We were then left with the task of looking for a delivery system that would suit our needs. We wanted to deliver a low application volume to give good capacity and to assist logistics, to provide high accuracy of placement, constant streaming of nutrients in the furrow and reliability in the system. The following is what we did and some of the lessons we learned along the way.

Design

We knew Brian and Pam Hedt and Dan and Suzi Wouters at Dimboola, Victoria had designed a liquid distribution system to suit their seeding

Hydraulic tube mounted on the back of the seed delivery tube.

operation so we visited Brian and used his design as the basis of ours. The most important aspect of the Hedt's system that we emulated were the use of blunt hypodermic needle ends as the applicators behind each seeder tube (referred to as dispensing needles by Portland Surgical).

These give an exact measured stream of fluid which is under pressure thus allowing a consistent stream of liquid into the furrow. This positive pressure at the point of exit is important for keeping the system flowing and to stop the plugging of the needle ends with dirt/organic matter.

We believe this system of liquid delivery is superior to using nozzle bodies or garden/horticulture dripper ends as they vary in their inside diameter too much.

By using blunt surgical needle ends the delivery volume at each tine is exactly the same as the next and consistent across the seeder. This system of delivery allows low volumes to be delivered at pressure at the point of application. The system is simple and effective.

Equipment
We used a Raven® 440 controller, www.ravenprecision.com, a RFM Raven® flow meter and a 3/4" Poly Control Valve (Butterfly) as these specialized in the range of flow we wanted to regulate which is between 0.3-15.0 GPM (Gallons Per Minute).

You can view this equipment on the Raven website at the above address.

It would not have been a problem to use almost any controller for this application, however, we chose the Raven® 440 specifically as we use the same one in our sprayer. We bought it with the intention of having it as a spare for either system if required.

We used a Hypro® hydraulically driven centrifugal pump for agitation and pressurization of the system. The use of a centrifugal pump, we believe, is important to provide the shear forces necessary to put into solution and to keep there the various nutrients we are applying and mixing.

We used Wilger® spray nozzle bodies assembled to form manifolds at each air head for equal liquid application across the tines on the bar. These nozzle bodies have diaphragms to stop the system draining if the solenoid is on and the tank tap is left in the open position.

We used a 100 mesh filter before the Raven® flow meter, flow control valve and delivery lines to filter any particles that could cause an issue in blocking the needle applicator or the Wilger nozzle bodies.

The solenoid control valve is wired to the Raven® controller master switch so that turning application on and off is easy.

The nutrients are mixed and kept in suspension to apply in a Computerspray® 2000 litre tank that we fitted a larger Rapidspray® tank lid to - this makes adding the micronutrients easier.

We used a 205 litre poly tank for a flushing tank (located on the seeder A-frame in front of the main tank) for line flushing requirements.

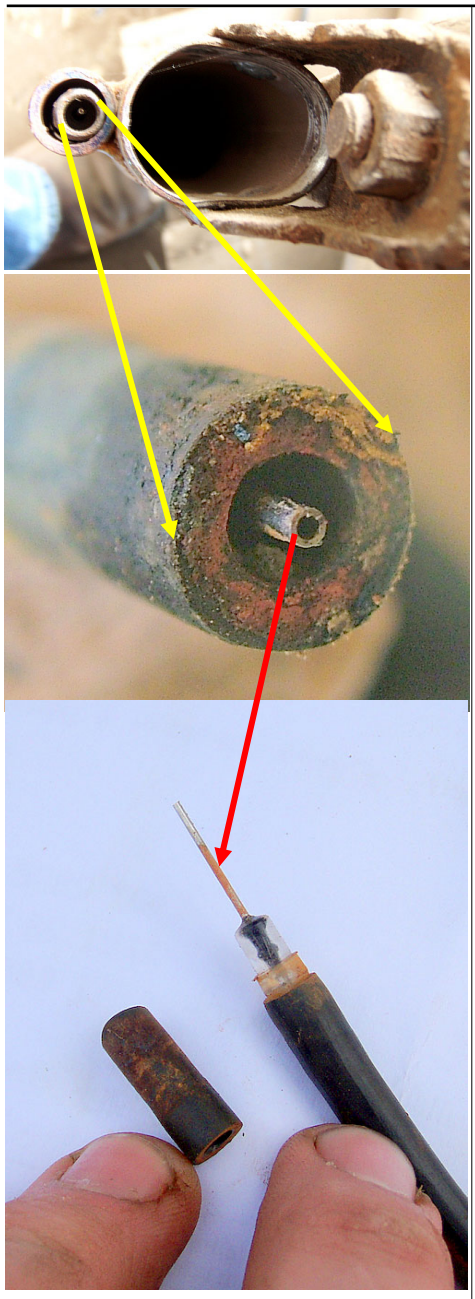
The blunt needle ends were manufactured especially for us by Portland Surgical and are made inserted into a plastic luhr. These needle assemblies are fitted to a length of 4mm dripper tube and to a straight barb fitting on the Wilger® nozzle body at the other end, glued with super glue.

The apparatus that holds the dripper tube, is made up of 12mm steel hydraulic tube that the 4mm dripper tube with needle inserted fits easily. To hold the needle seated at the bottom of the tube, the hydraulic tube itself is crimped by the manufacturer Horsham Hydraulics.

A small piece of dripper tube is also fitted over the needle/luhr assembly to hold it in position in the tube against the crimped bottom end of the hydraulic tube. This too keeps the needle end centred for accurate liquid aim into the furrow.

The hydraulic tube is also flared at the top and a 16mm Metric nut is either brazed or welded to the hydraulic tube to fit a 16mm gland nut with lock nut to

Bank of Wilger nozzle bodies for distribution of the liquids at the air head.



hold the dripper tube securely in the hydraulic tube. We shaped the hydraulic tube to our tines' shape using a jig that was effective and easy. It is essential to have gradual bends in the hydraulic tube to allow the dripper tube to be able to be pushed through the hydraulic tube.

Another important part of the system is a pressure gauge that measures immediately after the solenoid valve with the gauge positioned where it can be seen from the cabin during system operation.

Needle and Luhr in assembly (dispensing needle assembly)

Other equipment you would need:
Cable ties
Spray hose (we used 2",1¼",1" & ¾")
Super glue
Side cutters
Various gauge needles in luhr's (Dispensing needles)
Dairy brush for cleaning tubes
SupaLink
Hose clamps
Nut driver
Stanley knife
Hydraulic hose and fittings to fit the Hypro® pump to your tractor hydraulics

Assembly
1) The first step was to fit the tank to the bar, design and assemble the tank loading platform and then to research and purchase the pump and the Raven equipment for the project.

2) Steel hydraulic pipe shaping, fitting and gland nut mounting.

3) Tine adaptation for applicator hose mount. The assembly is held to the seeder tube with a hose clamp and a piece of steel tube that the 12mm hydraulic tube fits inside. The tube we used is 18mm OD and 13mm ID.

4) The assembly of Wilger® nozzle bodies into manifolds, plumbing and wrapping the liquid fertilizer tubing around the seeder tubes.

5) Fitting applicator needles into tube and onto the Wilger® barbs was the final job when all the hydraulic tubes were mounted on the tines. For this both ends were fixed using Locktight® super glue and the delivery lines were then located in the hydraulic tube. The gland nuts were tightened to retain the tubes in position and the system was ready to run.

Cost Breakdown
Needle ends and Luhrs $471 (4 sets of sizes – 18, 19, 20 and 21guage for different delivery volumes)
Wilger Nozzle bodies from SNE $1375
Steel hydraulic tubing cut and pressed to hold delivery hose behind the tine $412
Raven 440 controller $5427
Miscellaneous fittings, steel, spray hose $1584
Secondhand Computerspray tank $750
Labour, all done by my father and I on farm (~$3000)

Total cost ~$13,019 (+ GST)

Operation
This season we applied a 40 litre/ha application rate of solution using 20 gauge needles which worked quite well. In 2008 we will experiment with smaller diameter needle ends to give a lower application volume to aid logistics.

Needle blockages can be overcome by using high quality water, adequate operating pressure (we operated our system at 175-300 kPa), always having some type of solution being applied through the needles when in contact (just water is fine) with the ground and the addition of SupaLink to the tank mix. *(Ed: Supa Link has proved to be very useful with liquid carts. Any agents who sell Agrichem products will be able to supply it. See* www.agrichem.com.au *for more info.).*

If all else fails, and some needle blockages can't be remedied with the above techniques then you may need to have a few steel guitar wires handy to poke up the needle to free what obstacles are there.

If many needles are blocked at the same time this may indicate that the operating pressure is too low. You can increase operating pressure by reducing the amount of bypass (closing up the bypass tap) or by manually increasing the application rate using the toggle switch on the Raven controller.

Filling the tank in the following order has caused us minimal problems.
Fill tank with water, open plumbing to full agitation, add least soluble fertilizer (eg Zinc Sulphate Heptahydrate) allow Hypro® pump to break it down, add other fertilisers with powders first (eg Sodium Molybdate) add other fertilizers (Copper, Manganese etc..) add SupaLink at 1% of volume.

We check for nozzle blockages at the same time we check seeder tubes (eg at

Ryans: Tanks and filling platform (white tank is for flushing, yellow tank is the main Computerspray tank).

seed/granular fertiliser filling) and this seems adequate. When first using your system watch for liquid fertiliser hoses being snagged on areas of the seeder when it is being folded and redirect as required (the same as you would for seed delivery hoses).

Changes for next time
We would try to use plated steel hydraulic tube (could only get non-plated tube at time of assembly) that are now showing surface rusting. Rusting of the inside of the tubes could be an issue so in the future we will need to keep the seeder under cover in the off season to save deterioration of this extra equipment on the seeder bar.

We would not try and set the system up for Phosphoric acid as you need to be quite careful with plumbing fittings and this is hard when you are setting the system up from scratch and changing fittings all the time to adapt the plumbing to your bar.

Advantages from liquid phosphorus fertilisers appear to be marginal in our duplex acid soils from current research. The Hedt's system at Dimboola is almost exclusively set up for liquid phosphorus application as there is a real advantage in their alkaline soils.

We would plumb and assemble the Wilger® nozzle bodies horizontally for a manifold to give better access to inspect leaks and problems with diaphragm wear.

Our tank blocks the centre view of the bar to some extent as it is mounted on the A-frame. Different designs may be able to use a different shape of tank for better visibility.

The Computerspray® tank is very good in terms of shape for agitation and mixing and this makes it a good choice for this application.

We used Banjo fittings and the Raven metering equipment in case we used the system for Phosphoric acid delivery.

As we will most likely not be going down this path this was an unnecessary complication for us in our system. It is much easier and probably cheaper to use standard poly plumbing fittings you can readily source off the shelf anywhere if you are not delivering potentially corrosive compounds through your system.

Nutrition Strategy
We applied Zinc, Copper and Molybdenum this year in the fluid injection system and applied our Phosphorus in the form of a granular MAP (Mono Ammonium Phosphate) with the seed as has been standard practice previously.

We have set out some strips using Agrichem® products for comparison and these are looking promising as our treatments are compared to untreated areas.

List of suppliers

Wilger® spray nozzles
From:
SprayNozzle Engineering
P.O. Box 467, Moorabbin, VIC 3189
1-8/27 Shearson Cres.
Mentone, Vic. 3194 Australia
Phone: +61 (03) 9583 2368
Fax: +61 (03) 9585 0218
Email: sales@spraynozzle.com.au

Horsham Hydraulics
84 Golf Course Road
P.O.Box936, Horsham, 3402
Phone (61) 3 5382 0574
Fax (61) 3 5382 5646

GOLDACRES
Raven® components
Banjo tank fittings
Hypro® pumps
www.goldacres.com.au
1 Northwestern Rd, ST ARNAUD VIC 3478
Telephone: (61) 3 5477 3991
Fax: (61) 3 5477 3908

Portland Surgical
11-15 Beverley Street Portland,
Victoria 3305
Phone (61) 3 5523 3000
Fax (61) 3 5523 5500

Rapidspray® tank lid was sourced from a local supplier.

Capillary pressure gauge from local supplier.

Dripper tube from any local garden supply centre.

Time taken to assemble, source and build
It took approximately 3 weeks with 2 men working full time to design, source equipment and build the finished product. A huge help was having the starting point of the Hedt's design and their contacts regarding the blunt surgical needles and their method of holding the delivery tubes behind the seeder tubes.

Observations of crops where micronutrients have been streamed on at seeding
Canola crops where half paddocks were applied with Zinc, Copper and Molybdenum on our farm were more even and produced more biomass, flowers and pods than paddock halves with just water applied in furrow.

Cereals have shown greater early vigour, however the differences in half paddocks has diminished visually as the season has progressed.

We have yet to see how yield will be affected if we harvest crops this season. At the moment the most likely scenario will be that we will cut crops for hay. Our rainfall total for the year to date 30th Sep 2007 has been 220mm with our long term annual rainfall being 511mm for the calendar year.

Daniel and Peter & Audrey Bird, Wickepin, WA.
windorahfarms@clearmail.com.au
Phone 0427 913464

The reasons for wanting to get into banding liquids was because of our high requirement for trace elements ie zinc, copper, manganese and molybdenum. Also getting an early application of Flexi-N (UAN) on was eliminating another pass with the boomspray.

It was established that by banding it was a cheaper and more effective way to apply trace elements, which allowed us to use a cheaper granular fertiliser ie MAP thus cutting down on applications rates getting more hectares out of the air cart. By banding, this then allowed us to add in a fungicide application relatively cheaply. We had a limited budget so it had to be a cheap yet effective and a practical setup.

We used a 2000L Rota Mouldings tank mounted on our existing air cart via mounts for a third tank. Agitation outlets were mounted on either side of the tank with supply from a Honda driven 2" Banjo poly pump. The filtration system on the agitation line provided constant filtration through a 50 mesh filter. All quality Banjo taps, fittings and general plumbing were used.

Delivery from the cart to the bar was via 1" hose through an electric ball valve controlled by a Farmscan Primo 400 spray controller, which is mounted in the cab. A low rate flow meter was mounted after the electric ball valve then another 100 mesh filtration system was mounted for final filtration before being distributed to the manifolds. The monitor has all the basic functions required for liquid applications. Even more basic and cheaper monitors were available.

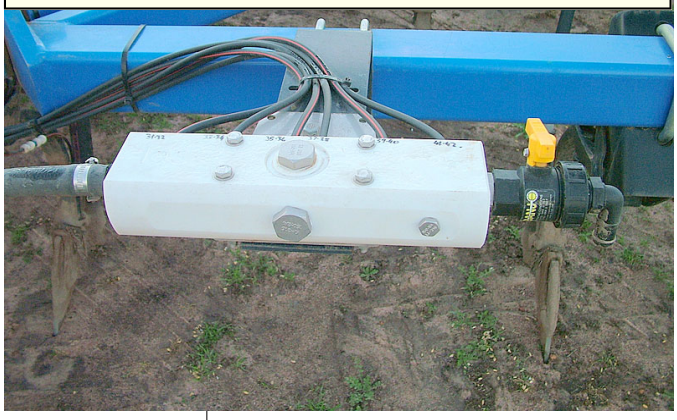
As the distribution was the most important area, an off the shelf kit was used from Liquid Systems in SA. This comprised of a "stacker manifold system" for the even distribution to each tyne via in line meters and terminal jets (these are explained on their web site) to an Agmaster point with the liquid block to accommodate the liquid line.

This system was chosen as there are no orifice plates and diaphragms to get blocked.

Products that were banded were Flexi-N @ 40L/ha, Coptrel, Twin Zinc, Mantrac, Sodium molybdate, and Triadimefon granules at a total application rate of 50L/ha. The pump was run at 250 kpa with most of the product running through the agitation line, while pressure at the bar was 100kpa. This was sufficient to provide even flow to 42 tynes at 8.5-9.5km/hr.

The products were all premixed in water via a granni pot at the chemical shed then added to the Flexi-N. It was then transported in a 12,000L Freedom cartage tank on a trailer behind the truck with seed and fertiliser. The 2000L tank was refilled approximately every 40ha or when the seed and MAP was refilled. The liquid side of things added approximately 10

Above: Electric ball valve, low rate flow meter and secondary filtration system mounted off the front of the bar for easy flushing. Ball valve is controlled by a Farmscan Primo 400 spray rate controller. From here product is distributed to the manifolds.
Below : 1 of 3 manifolds distributing product to the tynes. The block has a series of ports with no orifice plates or diaphragms which means no restrictions so blockages did not occur. In line meters were used at the tyne to restrict flow giving a constant even flow to each tyne.




Bird's

minutes to the filling time.

For next year we will look at replacing the Honda driven pump for a hydraulic drive Hypro pump. Although the Honda Banjo pump was a cheap and effective option for year one, a hydraulic driven pump requires less maintenance and refuelling.

We will also attempt to use zinc sulphate and manganese sulphate products as they are cheaper than the liquids.

If I was using a poly pump again, I would make sure the pump had a stainless steel shaft as there was some corrosion which caused a seal to fail.

Generally this was to be a cheap as possible option for year one to experiment with liquids. The system worked very well and proves that 10's of thousands of dollars doesn't have to be spent to get an effective and reliable system.

To build this setup cost approximately $12,000 excluding the cost of the 12000L cartage tank. This system was used over a 2300ha cropping program with the only major downtime being a faulty flow meter. Good agitation is required along with good hygiene. Flushing the system and cleaning filters would be recommended every couple of days.

Costing
2000L rota moulding tank $1500
250L flush tank $300
Honda driven 2" poly Banjo pump $900
Filter assembly, Banjo taps and plumbing $1500
Low rate flow meter $900
Electric ball valve $420
Farmscan Primo 400 spray controller $2500
Liquid Systems kit for 42 tyne machine $3700

Chris & Jim Kirkwood, Kendenup, WA.
mondurup@bigpond.com

We farm 2800ha near Kendenup and use Walker Double Disc Openers to do our seeding. We started out buying a liquid cart from Burando Hill (www.burandohill.com.au), which was a tow between. We used this for one year then converted it to a tow behind that was easily done by putting a dolly on the front as seen below. The main reason for this was visibility and for the fact that if it got wet and boggy we could take the cart off easily.

The liquid system was also bought from Burando Hill. It is made up of six manifolds, three front and three back (we have two rows of discs) and there are ten outlets per manifold. The two rows can be operated separately for when we seed wide rows when planting canola, lupins, peas etc. as the back row of discs are unbolted.

The orifice plates are placed in the nozzle body. These are changed when we use wide rows to narrow rows to be able to deliver the correct volume.

These will be replaced next year with new nozzle assemblies from Burando Hill (VR series nozzles). The new nozzles will enable us to go from 30 to 150ltrs without making any other changes therefore no orifice plates are needed. When blocked these new nozzles build up pressure and clear themselves.

We use 50lt/ha: 20-30lt of Flexi-N plus 20-30lt of water mixed with trace elements. Trace elements are mixed in a 800lt tank using a chemical centrifugal pump.

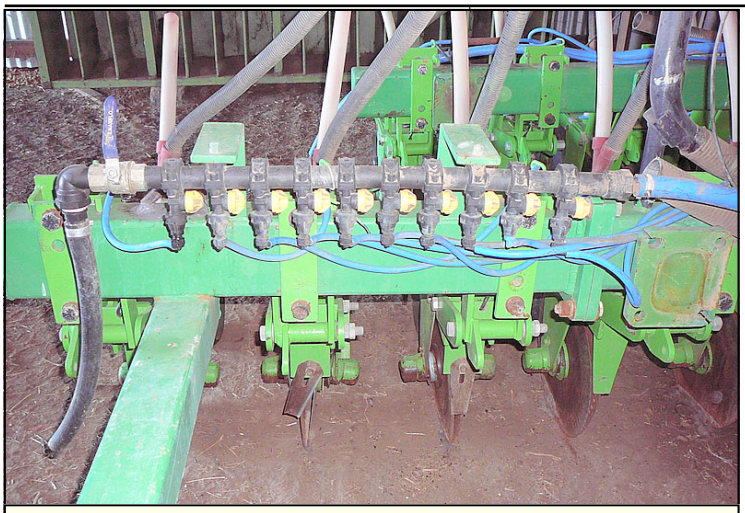
This is then placed in a tank on a truck. Water is added to the desired amount then topped up with Flexi-N ready to be put into cart. Rates of Trace Element are as follows:
Copper Sulphate 1kg/ha
Zinc Sulphate 2kg/ha
Manganese Sulphate 2kg/ha

This is also the mixing order with fungicides etc... being added after if desired.

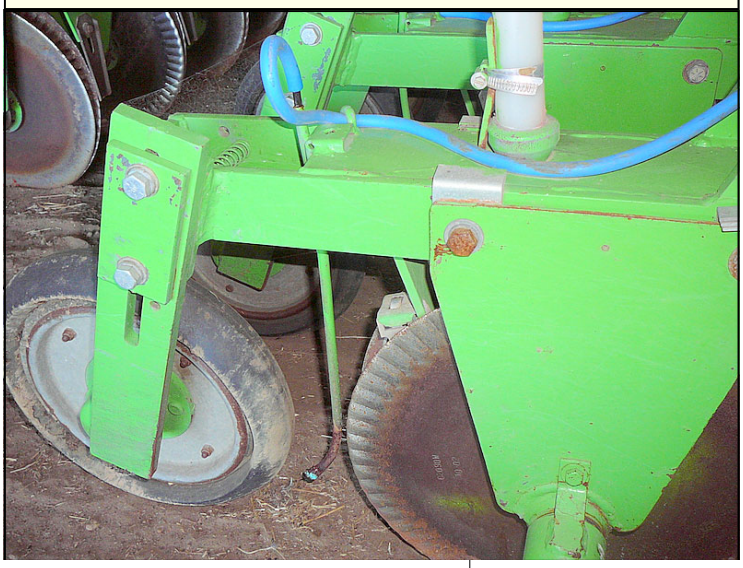
The Trace Elements mixed very well the first year with no problems. The second year with the same products, we had problems with the manganese settling out, blocking lines and filters, even with good agitation on the cart. Next year we may look at using liquid manganese to help solve this problem.

The liquid is filtered into the liquid cart using 80-mesh filter. Then we have two

Kirkwood's liquid cart.



A closer look at the Kirkwood's liquid distribution system and placement on their Walker disc bar.



finer filters before the manifolds as it is easier to clean filters than nozzles. We added taps to the ends of the lines for easy flushing. Flushing is done at the end of a day or if leaving for a lengthy period.

The placing of liquid is put behind the double discs and in front of the press wheel. When using discs there are not a lot of options where liquid can be placed.

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We began using a liquid injection system in 2002 for the main purpose of directly injecting Flexi-N (UAN). After spending time in the US using liquid fertilisers I saw this as a natural progression with liquids being more efficient for us both in timeliness and efficacy.

With liquid application only new, we started with the purchase of a Burando Hill 7000L FlexiN Cart, being a tow between, but we actually made a hitch to go on the back of the airseeder cart to reduce the amount of wheels. It was fitted with a ground driven John Blue pump, with the rate controlled through a Farmscan 22C6 monitor. The first year was certainly experimental, as it is amazing what these liquids can destroy and where it can leak from.

We use a pressure manifold system, using orifice plates through standard Teejet nozzle bodies. For placement on the tyne machine, we experimented with several ways as we had nothing really to work on and ended up welding a nut directly on the back of the Agmaster knife point and feeding flexible plastic brake line through it. This is what the current Agmaster liquid point is now based on.

We had several different locations across the bar during the season and it was by far the best, and most consistent, with others closer to the seed setting the crop back early. Using dye tests to see where you are actually putting it has been a great help too.

On the disc machine we tried dribbling it in the shadow of the front coulter which resulted in it being about an inch to the side and a little deeper. Reliable placement on the disc machine has probably been the biggest issue, as having it in between the disc opener has meant it was too close to the seed.

Having it on top of the furrow meant the fungicide and trace elements weren't close enough and you have to be very careful to not get it spraying onto and then off the disc as Flexi-N

Loui – Our liquid transfer truck. We mix the traces in as we load. Stainless steel tanker and 10,000L tank on truck with 1000L shuttles of sulphates in front.

Morris Air Cart with Liquid Systems setup.

Liquid Systems setup on 2nd Morris unit

and bearings don't mix. This year however we think we've found the answer. Still applying it in the shadow of the coulter we use a terminal jet and squirt it at pressure as opposed to dribbling.

Small streaming line on disc machine.

Liquid Line and Agmaster point on Morris tyne machine.

In '02 we used a standard rate of 60L, however experimented with higher rates and the addition of trace elements and fungicides, testing for uptake with plants tests in conjunction with yield maps and quality testing. We found that there was certainly a benefit with both and so in 2003 we added Zinc and Manganese sulphate solutions to the mix, as well as the fungicide and upped the standard rate to 80L.

Copper was also planned but tended to make the mix a little unstable and in the testing, the uptake wasn't quite there as much as foliar, so dropped it and apply it with the foliar's later.

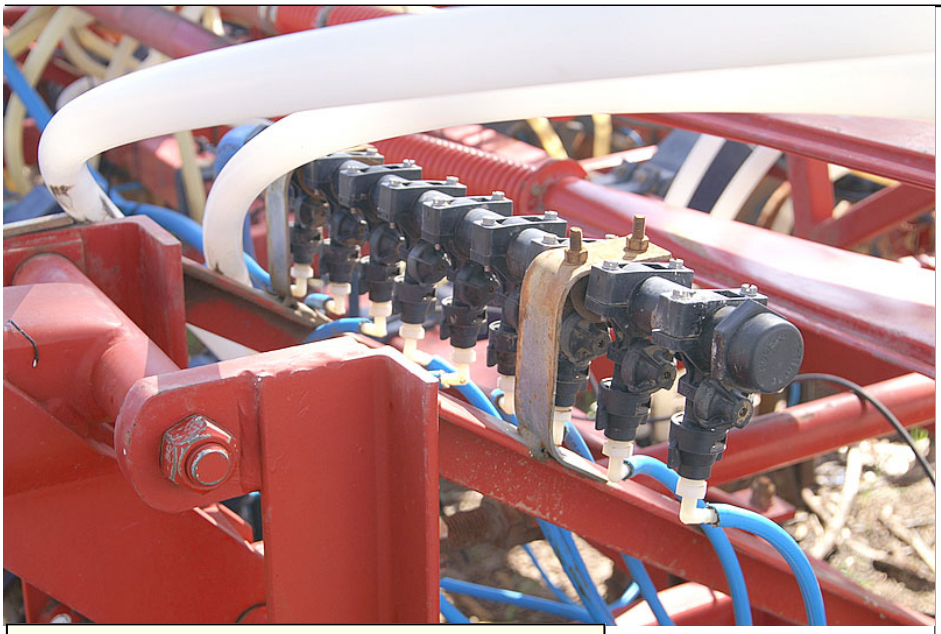
After success using an EC based Triadimefon in trials during 02, we planned to use it across the board in 03 and ended up having a lot of fun, with the solvents in it continually causing everything to fall out of suspension and block the filters along with the lines and orifice plates.

We fitted a separate pump with 2 super mixers for agitation, firstly a hydro driven poly, but that was soon destroyed, along with the need to replace seals at least one a week with the abrasive nature of the trace elements.

We then fitted a Hypro and have had little problems since. We also settled on using Impact because it is an SC and haven't had any issues with that since either.

In 2005 we purchased an additional air seeder cart already fitted with the Liquid Systems setup on it, incorporating the Bertollini Pump, TeeJet Servo and Section Valves and Flow Meters. This is definitely a better way to go than a ground drive system with it being so much easier with the ability to easily flush, check lines and calibrate without moving. A simple turn of valves and you can check the lines each fill if you like.

We only have the one pump and it has ample flow to supply the bar as well as provide good agitation with the super mixers in the tank. This system can be fitted to any liquid cart and can be bought in a bolt on package. We may fit one to the other cart for "08 as will work in with our planned additional injection system. Both Liquid systems are controlled through the Farmscan Canlink monitor in conjunction with the granular fertiliser and seed.



Beeck's: Manifold on Morris Tyne Machine

We tank mix everything on site during seeding, injecting the trace elements and fungicide in as we fill the tank. We found buying bulk sulphate based trace elements as liquids, although a little dearer, were far easier to mix and control meaning it remains an efficient one person job. We apply 2-3L/ha Zinc Sulphate (170g/L) and 3L/ha Manganese Sulphate (170g/L). This year we have dropped our up front rate back to 45L/ha of FlexiN.

We have not gone to using a Dosatron injection system as we have been planning to vary our N rates, along with the granular fertilisers which we have been varying for a few years.

For 2008 we are planning on using a separate system for trace elements and fungicides, drawing out of a smaller 500L tank and injecting into the same line. We are also planning on fitting the newer VR style nozzle bodies from Burando Hill as they will allow the rates to fluctuate over a greater range without the need to change orifice plates and they should also handle a little more inert or biuret matter get through, without blocking up.

This year we also used liquids on the lupins for the first time, using predominantly water with 5-20L FlexiN, the traces, as well as throwing in raw freeze-dried rhizobia for inoculation.

It has proven to be a top move as it is so easy, as well as being as effective, if not better than Alosca, which is already miles in front of slurry, and cheaper. It turns up in small containers in the post, dissolve it in water and pour it in.

Trevor Smith, Katanning, WA.
Mobile telephone: 0418 828015.

Noting the success that my neighbour had promoting healthy crop growth after adding the ability to apply liquid fertilisers to crops while sowing on their existing seeding equipment, I decided to include a system based on a similar principle to my combine.

Realising the need to test the placement of the liquid stream and see where it would be in relation to the seed I hosted a CSBP fertiliser dye night run by Luke Dawson in February 2006. I wanted to see if the height of the liquid outlet on the point affected the depth of the liquid stream.

Our findings indicated that it did not and that as long as the outlet was mounted so that it allowed the liquid to flow down the back of the point the liquid would reach full point depth before it became dislodged into the soil.

So a stainless steel pipe, mounted as high as possible, was added to each point and sized to allow the liquid plumbing to fit securely into without the need for fastening. Keeping this pipe mounted high on the point also helps to prevent soil plugging when the machine is lowered into the ground.

The combine then went to Katanning where Dean Earnshaw of Katanning Fabrication fitted the tank stand, flush and main tanks, clutch and pump, liquid and tap manifolds and modified the tynes to facilitate the liquid plumbing.

Tank Stand: High for good machine accessibility and visibility and well supported to stand the weight of over one tonne of moving liquid fertiliser.

Flush And Main Tanks: 100 and 1,000 litres respectively, both from Rota Moulding.

Clutch And Pump: A ground driven electric clutch was used to enable automatic start/stop control of the liquid system switched by the raising and lowering of the combine. The clutch then drives an Imovilli diaphragm pump which I used as its capacity was more than adequate for both liquid agitation and distribution and it was considerably cheaper than the alternatives.

It is also important to include a pressure gauge for monitoring. I also suggest obtaining operating speeds for existing shafts for ground driven systems before beginning modifications. This point would have saved us much trial and error. The 'Squeeze' pump is also worth a mention here, a clever all in one pumping/distribution system.

Liquid And Tap Manifolds: The liquid kit, including the manifolds, came from Burando Hill PTY LTD of Katanning. Entering values specific to my machine including desired application rate, operating speed, tyne number and spacing etc into their computer program allowed the calculation of the orifice plate hole size that I would require.

These orifice plates fit into the caps on the liquid manifolds and together with pressure regulate rate. The tap manifold allows flexibility when filling and emptying the liquid fertiliser system. Filtration is also important and I have included both fill and pump suction filters.

Tynes: Getting the liquid down the tynes, past the point/seeding boot mounting bracket and onto the back of the point, minimizing the risk of damage while seeding, proved to be a real challenge. We decided to place a groove in the back of the tynes under the bracket to achieve this.

Considering the amount of untested modifications made the entire system performed well and has now completed its second year without the need for much alteration.

In the first year we added fungicide and one trace element to the liquid fertiliser. Pushing it further this year with three additional trace elements which did cause some sediment issues due to lack of stationary agitation hopefully rectified for next year with the addition of a motor driven pump.

To move the liquid fertiliser from the storage tanks to the paddock I added two tanks, clean water and liquid fertiliser, plus a pump to an existing trailer which is towed by the truck carrying the granular fertiliser/seed bin. The approximate cost of the modifications was $10,000.00 for the combine and $5,000.00 for truck trailer.

To end I would advise setting aside ample time to do modifications such as this. As I found out, it is considerably more complicated and time consuming than simply 'Putting a tank on a combine'.

Liquid Experience

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In the field of Australian liquid fertiliser application with trace elements and fungicides, there seems to be a lack of substantiated evidence and research. When asked, I was initially reluctant to comment on liquid experiences given my evidence also has limited replicated trial data.

Given these shortfalls, I am nevertheless advised that this makes information sharing all the more important. What I do say is with certainty of belief and many dollars worth of experience points to establish some of the truth.

1993 Began no-till in earnest with a Conserva Pak allowing us to safely drill the majority of the crop's NPK requirement at sowing. Commonly MAP, MOP, & Urea.

1995 -1999 Urea drilled below and to the side of the seed was shown to give a growth lag period and delayed access to other nutrients, especially Phosphate in the first four weeks. An enormous flush of Nitrogen was then evident some four to six weeks post sowing. High seeding rates at the time masked poor tillering but small heads were seen to be common.

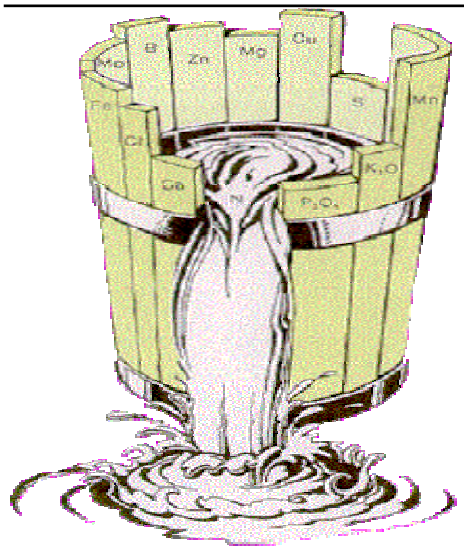
1998 - 1999 Applied Nitrogen in excess of 30 units correlated overwhelmingly with Frost susceptibility and to multiply Frost loss risk many times.

2000 Shifted to a low nitrogen regime with greater emphasis on other macro and trace elements as per Liebig's Law of the Minimum (see picture on next page).

Witnessed some disparity between plant test results and visible symptoms the plant was displaying. Moved to fertilising by displayed symptom with the reasoning that plants have no sales agenda. Less cynically, maybe the threshold guidelines just needed further refinement.

Liebig's Law of the Minimum, states that growth is controlled not by the total of resources available, but by the scarcest resource. This concept was originally applied to plant or crop growth, where it was found that increasing the amount of plentiful nutrients did not increase plant growth. Only by increasing the amount of the limiting nutrient (the one most scarce in relation to "need") was the growth of a plant or crop improved.

Liebig used the image of a barrel to explain his law. Just as the capacity of a



Liebig's Barrel.

barrel with staves of unequal length is limited by the shortest stave, so a plant's growth is limited by the nutrient in shortest supply.

The image above unfortunately shows N in deficit, rather than as in our case the crop displayed visual deficiency in mostly Potassium (K_2O) and Zinc (Zn).

2001 – 2007 Established some experience with banding UAN, & mixing trace elements and fungicides with UAN through both tank mixing and injection methods of application.

UAN was found to be safer than Urea and gives a more even release of Nitrogen without limiting other nutrient uptake. The flexibility of staged applications is a real plus when playing the season.

Trace elements by compound fertilisers found not to return the same levels on a plant test as those of equivalent amounts applied in the liquid stream.

Injection of SC fungicides (like Impact) works well with UAN with vast reduction in diseases. Injection works better if SC compound is pre-diluted with water. Usually in a 50% product 50% water mix. EC formulations of fungicide are far less predictable.

2007 - Application of trace elements & fungicide in the following blanket mix with UAN 25L/ha and water added to 50 L/ha total volume:
Copper – 50g/ha or 100ml Coptrel
Fungicide – 250ml/ha using Impact (Flutriafol)
Zinc – 215g/ha using 800g Zinc Sulphate
Manganese – 280g/ha using 1000g Manganese Sulphate.
Calcium – 5L/ha Calsap

Discovered that the mixing quality of granular sulphates and level of impurities varied from supplier to supplier.

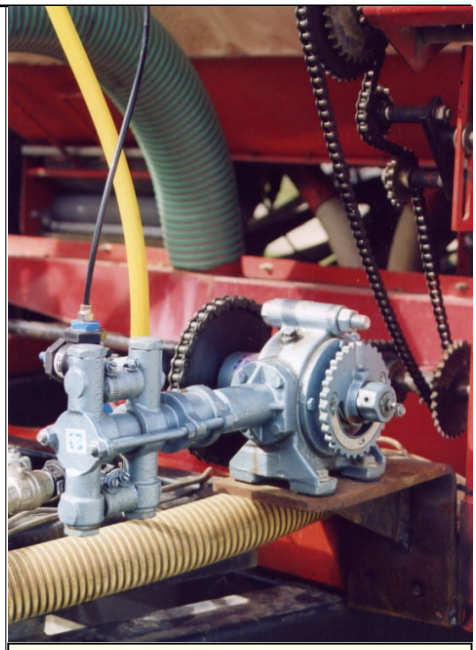
Discovered that order of mixing was important and could only be mixed as listed above. Also pre-batching was not possible as if left to stand, a brown sludge would form and continue to grow.

Later in the season lower temperatures seemed to compound problems with crystals growing and blocking orifice plates and brown sludge forming on filters more often. Tried various combinations of leaving each product out to identify the source of the problem. Extensive jar testing also. Narrowed it down to combination of Zinc Sulphate & Manganese Sulphate.

Flexi-N (UAN) & Impact 250ml/ha

Also tried replacing all sulphates with equivalent g/ha rates of oxides and had the same result. Tried injecting oxides and found the formulation was harsh on injection equipment and in any case the result was the same.

Best outcome and conclusion was to separate and inject sulphates in a super-concentrate 3L/ha and tank mix the oxides with the fungicide.



John Blue FU551 Fungicide Pump

Future
Liquid Cart tank agitation was limited and will be improved. Super-Link may be tried. The price of sulphate form traces is very attractive and still warrants further investigation, particularly pre-formulated liquid sulphates.

Liquid cart thoughts? Many are going for the option of multiple injection units, e.g. a Dosatron unit for each product, others opting for tank mixing with extreme agitation. Obviously having both options was the answer for me this year.

However, having used both, head to head, I feel that there is some comfort in knowing that the product must go out at the right rate in a tank mix and that perhaps outweighs the convenience of injection.

As the number of products that you wish to apply goes up the money favours tank mixing, if they are compatible.

As an industry we need to put it to suppliers that there is a ready market if they can produce a stable, multiple trace element product, fully compatible with UAN.

Liquid Systems the company

By Peter Burgess
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(ED: As well as asking farmers to write down their experiences, I thought it would be good to hear from one of the major suppliers and fitters of equipment used with liquid carts in Australia. Peter Burgess is the manager of Liquid Systems, a company based Adelaide, South Australia, but has distributors throughout Australia).

I first became involved in designing liquid furrow banding systems seven years ago, in conjunction with the Minnipa Research Centre on the West Coast of South Australia.

The Research Centre team, under the leadership of Dr. Bob Holloway, was conducting a series of liquid trials on the grey, highly calcareous soils of the region. Phosphoric acid was the main liquid being banded and some astonishing yield increases were realized from these trials.

Phosphoric acid is an extremely corrosive liquid and great care must be taken in the selection of the system components to successfully handle this product. The experience gained during these trials and the success of the project spurred me on to further develop my systems for commercialization.

My work in system design caught the attention of several Western Australian parties who saw the potential in utilizing my systems to furrow band UAN and actively encouraged me to pursue this avenue.

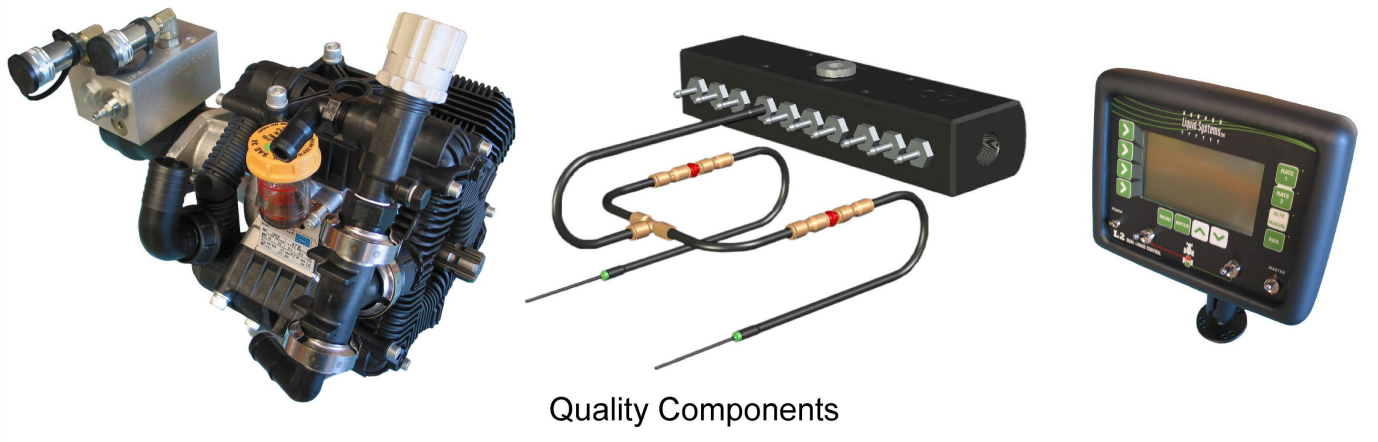
Precisely banding a single liquid was only the first step. It became obvious that the primary liquid could be utilized as the carrier for various other products such as trace elements, fungicides, soil wetter and inoculants.

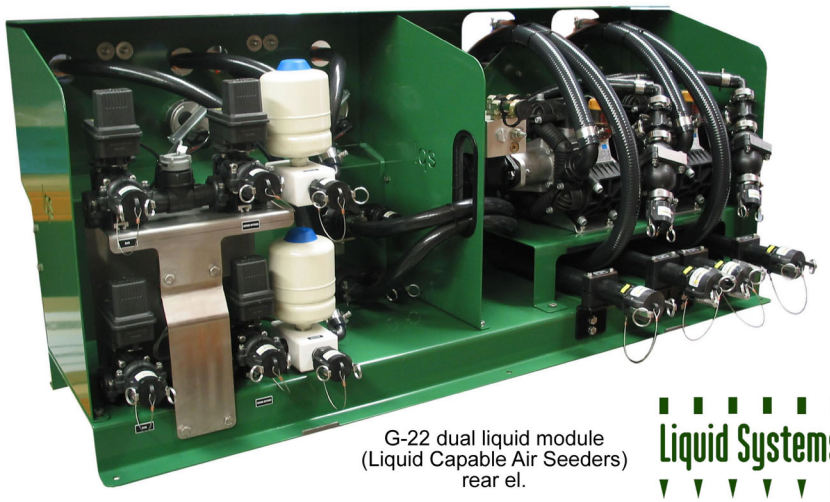
Various systems were subsequently utilized to introduce these products to the carrier and mechanical, proportional dosing (Dosatrons) and EXA (extreme agitation tank mixing) were both successfully employed to carry out these tasks.

From the outset I have designed and constructed only quality products and systems. Experience has taught me not to take short cuts, it simply isn't worth it! My systems are designed to precisely apply product across the entire bar width and maintain unbroken terminal streams at rates as low as 25 litres per hectare.

Our systems feature auto-rate control using our own L2 – (Dual Liquid) Controllers and can be interfaced to most commercial guidance / control systems for variable rate product application. We place a lot of emphasis on precision application and many of the system components are unique to Liquid Systems (SA).

Originally we designed and manufactured only retro-fit systems





G-22 dual liquid module
(Liquid Capable Air Seeders)
rear el.

Liquid Systems (SA)

that were adaptable to existing machinery such as liquid carts however liquid capable air seeders are now rapidly gaining popularity. We now supply the majority of manufacturers of liquid capable air seeders available in Australia with our systems.

Things have progressed dramatically since simple single liquid banding regimes. We now manufacture dual and triple liquid system configurations for single pass operations where we can apply a pre-emergent spray for instant ground incorporation, band one or two primary liquids and inject trace elements, fungicides etc. into the primaries. Multiple liquid set-ups also provide the operator with many options in regard to chemical incompatibilities.

2008 will see the introduction of 'EVI', Electronic Variable Injection. I designed this system following numerous requests from clients for a means to inject a compatible mix of trace elements, fungicides etc. into a carrier liquid at a rate that is at variance and disproportionate to the carrier. There are some very real reasons for such a system.

Firstly, most fungicides need to be agitated to stay in suspension. Secondly, some high analysis trace element configurations are too viscous to be mechanically, proportionally dosed into the carrier liquid and thirdly, proportional dosing systems are inextricably tied as a percentage rate to the carrier.

There are many clients who wish to variably apply a carrier such as UAN using mapping techniques but who also wish to apply trace elements etc. at the same time but at a rate that is not proportional to the carrier.

EVI utilizes a small piston diaphragm pump in conjunction with a simple precision rate control system capable of delivering flows lower than 1 litre per minute via high pressure injection directly into the liquid fertilizer/carrier supply line to the bar. EVI draws product from a constantly agitated, dedicated trace element / fungicide tank.

Forty years experience in product design, engineering and manufacturing together with persistence and attention to detail has enabled me to place Liquid Systems (SA) at the cutting edge of the industry.

To my knowledge we now manufacture the most comprehensive range of precision liquid banding systems in the world. Adding to this, for the 2008 season we will introduce a range of unique Liquid Systems (SA) after-market components that will enhance adaptability of terminal assemblies to commercial ground engaging tools including disc openers.

We will continue our research and development activities in conjunction with government research institutions, grower organizations, liquid fertilizer manufacturers and chemical companies thus ensuring the industry has access to the best information, products and equipment available.

Please visit our web-site www.liquidsystems.com.au for more information in regard to our systems, your nearest Liquid Systems (SA) distributor and important industry links.