Sarah Clack:

So, today we have got Nick O'Halloran with us from Agriculture Victoria, along with Andrew Murphy and Sam Thompson, who are both irrigators. So just a bit about Nick to start off with. Nick is an irrigation extension officer with Agriculture Victoria, based at Tatura, and has had 20 years of experience working in irrigation and soils research and extension with Agriculture Victoria. So, Nick works with irrigators across Northern Victoria to help them adopt efficient irrigation technologies and practices, including irrigation scheduling tools, whole farm planning, and managing soils and soil variability.

Sarah Clack:

So, Nick has undertaken around 50 assessments of pressurised irrigation systems, assessing pump performance, application uniformity and energy efficiency, and has found a considerable opportunity for improvement in design, maintenance and operation of these systems. So one of Nick's passions is getting out on farm and helping farmers finding ways to farm better. So we have got Nick here today to talk about energy efficiency and irrigation systems and Andrew and Sam will speak about their irrigation systems and what they do on farm and changes that they've made on their irrigators to improve the energy efficiency. So I will hand over to Nick now and we'll get started.

Nick O’Halloran:

Righto. Thanks very much for that, Sarah. Sorry, I've just got a chook that's gone clucky in the background, so might hear that in the background. So as Sarah said, I'm an Irrigation Officer based in Northern Victoria. I work as a part of a team and we work directly with irrigators to provide incentives and information to help with irrigation management. One of the things that we're doing more of now is undertaking irrigation assessments, so looking at application uniformity and energy efficiency of these systems. And, as Sarah mentioned, I think there's huge opportunity for improvement in a lot of these systems, and I think a lot of it's just about understanding probably better monitoring of the systems and understanding whether the systems are doing the right job or not in the first place. So a lot of this is about monitoring that you can do to make sure the systems are working well.

Nick O’Halloran:

But what I'll be talking about today will be mainly focused on the energy side of those assessments we do. So I'll cover why we should be worried about energy efficiency with irrigation, how we go about measuring energy use and efficiency, and through our assessments, what opportunities we've seen to improve/reduce energy costs. As Sarah said, we've got Andrew and Sam here today. We've done assessments of their irrigation systems. So they're going to talk today a little bit about, I guess, the types of issues that they've seen with their systems, how they've found going through the assessment process and what benefit they've had to their system as a result. I really appreciate them coming on. It's a busy time of year; Sam's busily harvesting and Andrew's sowing corn. But it's really good to have you guys here and hear about that farmer experience, get the farmer perspective. And finally, I'll just touch on the development of an irrigation calculator that we're in the process of developing aimed at helping you understand how efficient your system currently is and what the likely benefits are going to be of improving or changing your irrigation system.

Nick O’Halloran:

So in Northern Victoria, there's a range of different types of irrigation systems. We have a lot of horticulture with drip and Microjet irrigation and probably a growing number of travelling irrigators like we see here, center pivots and lateral move irrigators. The majority of my work is with these types of irrigation systems. So, that's what I'll be talking about a lot and showing examples of that. But the principles are the same for any irrigation system. So hopefully, no matter what your system is, you'll get something out of this; and we are looking to do more work in the horticultural industry as well.

Nick O’Halloran:

So why should we be worried about irrigation energy efficiency? Well, over the life of an irrigation system, the pumping costs can far outweigh the capital costs of purchasing the system. So in this diagram, we've just got a 400 metre center pivot with a range of possible designs, different pipe sizes ranging from 143 millimetres right through to 254 millimetre diameter pipe. The capital costs, shown in orange here, range from about $250,000 up to almost $300,000. So we can see the lifetime pumping costs of the under-designed system are much higher, almost double the capital costs. Whereas, if we design the system well, the pumping costs are much less than the capital cost of the system. So the gray line's the total cost of owning the system. Really important that we do get that design right. So the best time to consider energy efficiency is in that design phase and get it right at the start. It's the cheapest time to get energy efficiency right. We'll look at ways that we can change systems once they're up and running, but it can be more difficult and costly.

Nick O’Halloran:

So the other thing that we've seen obviously is diesel and electricity costs have risen in recent times. And what we see is that in a lot of cases, energy costs, or the cost of operating these systems, is starting to dictate when irrigation occurs. So farmers will try to irrigate at night or on weekends to take advantage of off-peak electricity. If your system's designed well enough to do that, well, that's really good. You will save some money, but if it's not and you're compromising your scheduling so the crop's stressed, the yield penalties will quickly outweigh the energy cost savings. So the assessments that we do are really about trying to minimise those pumping costs for farmers so that you can confidently irrigate when you need to. So we look at application uniformity, so that's about making sure water's going out evenly, and that minimises the amount of water that needs to be applied, reducing water costs and energy costs. The other side is looking at the energy efficiency of the pumping system to reduce overall energy requirements.

Nick O’Halloran:

Measuring the energy use of a pumping system is actually pretty easy. Most people could easily do it. All we need to do is measure power consumption or diesel consumption over the same time as we measure the amount of water applied. So we need a dedicated power meter. So make sure that there aren't other appliances or irrigation systems operating off that meter, or, if there are, that they're turned off when you're doing the assessment. And take a reading at the start and the end of an irrigation event. Also need a flow meter, which some systems don't have them. We have a portable system that we use when we do our assessments. But we just need to know what the flow rate is during that irrigation so that we can work out how much water's applied. And that gives us energy consumption in kilowatt-hours per megalitre of water pumped.

Nick O’Halloran:

Now, when we want to know the efficiency of that irrigation system, we also need to know the pressure that it's operating at. So we need a pressure gauge as close to the pump as we can get. And we also need to get an estimate of the suction side of the system, so how much suction pressure is required. But that's a much smaller component of the total pressure, and we can usually estimate that. So that gives us what we need to calculate energy efficiency, which is kilowatt-hours of energy per megalitre per metre of head. Metre head is just another unit of measuring pressure. One metre head is equivalent to about 10 kilopascals or 1.4 PSI. It's a bit tricky in irrigation, a whole range of units are used, but in our energy tool, we've developed it so that you can just put in whatever units are on your equipment or on your gauges and it'll do the conversions to metres head for you.

Nick O’Halloran:

So another measurement that's really important to do to make sure the system's operating properly, first of all, is to measure the residual pressure. So, that's the pressure at the extremities of the system, either on the high points or for a centre pivot, at the end of the centre pivot. And that's really about making sure, first of all, that there is sufficient pressure in the system. If the pressure's not high enough at the end, then you'll have a uniformity problem. There'll be less water going out at the end of the system. You might actually have to increase pressure and therefore pumping costs to get that uniformity right. And that's going to be more important than worrying about energy efficiency at that point. But if there is excess pressure at the end of the system, then there's an opportunity to reduce pumping costs there.

Nick O’Halloran:

For drip systems, the pressure that you require will usually be defined in the specifications of the irrigation system, in the design, but for lateral moves and centre pivots, each dropper above each sprinkler, there's a pressure regulator and it'll have a pressure rating. So this is a 15 PSI regulator. For that system to be working properly, we need at least five PSI higher than that above it. So we're looking for 20 PSI above a 15 PSI regulator. So, that's the first check we should do to make sure the system's operating well.

Nick O’Halloran:

When we're looking at the energy consumption of a pumping system, there's two components we need to look at. There's the pumping system efficiency. So, that's essentially how efficiently the power, electricity or diesel, is being converted into the movement of the water. We also look at the total dynamic head of the system, so the pressure that pumping system has to work against and therefore, yeah, how hard that pump has to work. So for the pumping system efficiency, if it's 100% efficient, so there's absolutely no energy loss in that pumping system, it's all converted into the movement of water, we'll use about 2.7 kilowatt-hours per million litres of water pumped per metre of pressure we're pumping against.

Nick O’Halloran:

But the systems are never a hundred percent efficient. There's efficiency losses in the motor so we've got to size the motor right and we've got to keep that well ventilated and cool. There's efficiency losses in the drive system. So direct shafts are quite efficient, but belts can slip and be fairly inefficient. And there's efficiency losses in the pump itself. And ideally, pumps will be better than 70% efficient. But how efficient that pump is, is determined by how well it's suited to the irrigation system it's attached to.

Nick O’Halloran:

So the pump has to be designed so it has to be the right size, the right size inlet, the right size outlet and the right size impeller for the duty point of the irrigation system. So the duty point is a flow rate and the pressure that the irrigation system requires. So if we change the duty point of the irrigation system, so change the pressure requirement or the flow rate, the efficiency of the pump will change. And if we change the duty point enough, the efficiency of the pump might change so much that we actually need to change the impeller size or change the pump altogether. The range of efficiencies we've seen in our assessments are from as high as 80%, which is really good, down to as low as 30%. So an 80% efficient pump will use a bit over three kilowatt-hours per megalitre per metre of head compared to a 30% efficient pump will use over nine kilowatt-hours per megalitre. And that's all related to how well this system's set up and matched to the duty point of the irrigation system.

Nick O’Halloran:

So some of the common causes of poor pump system efficiency is incorrect pump selection. Sometimes that's just because the wrong pump was pulled off the shelf or out of a shed. That should never be done. You should always make sure the pump is the right pump for the irrigation system. I think in a lot of cases, the irrigation system's designed on paper and the pump selected, but once it's built, the flow rates and pressures are all a little bit different and so the pump mightn't be perfectly matched anymore. So, that's why it's worth going through this process. For older systems, we get pump deterioration, so impellers deteriorating or the wearing rings wearing, deteriorating, and that'll reduce the efficiency and might require an overhaul of the pump.

Nick O’Halloran:

The suction line also has a big impact on the efficiency of the pump. So if there's any restrictions to water getting into that pump or turbulence of the water going into the pump, then that'll cause inefficiency. We've had one example where there was a sudden contraction, so the pipe size reduced in size just before the pump. And that was probably causing a 10% reduction in efficiency because of a bit of poor design there. So we're still working to try and quantify that and check that we can improve that system. The other big common cause of poor pumping system efficiency is where we don't have mains electricity, we've got a diesel motor and generator providing electricity to the motor and there's inefficiencies in that diesel motor and generator. And if that's not sized correctly, it can have low load on it, and that can result in very poor efficiencies and is actually the case, what was causing this 30% efficient system. We'll also have a look at that in Sam's situation. It's not quite as bad, but that diesel motor and generator is causing some issues.

Nick O’Halloran:

So, that's just the pumping system. The next thing we've got to look at is what pressure does that pumping system have to work against to push water through the irrigation system? So as water moves through an irrigation system, there's turbulence and friction loss and that means that the pressure at the start is lower than the pressure at the end. So in this system, we want to achieve 10 metres of head at the end. We've got to apply 50 metres of head at the pump to overcome all that friction loss. So to work out the energy consumption of the system, we multiply the efficiency of it by the number of metres head experienced at the pump.

Nick O’Halloran:

So for the 80% efficient system here, it's using about 170 kilowatt-hours per megalitre compared to the 30% efficient systems using over 450. So if we can change the irrigation system, so in this case increasing the pipe's size, the delivery pipe to the pivot, there's less friction loss. With a larger pipe, we can have a lower pressure at the pump. So we now multiply that lower pressure by the efficiency and we've effectively halved the energy consumption of that system, achieving the same pressure at the end. So the system's still doing a good job.

Nick O’Halloran:

So you can see both that pressure, the total dynamic head or the total pressure required of the irrigation system and the efficiency of the pumping system, are both really important in minimising energy costs. You can have a highly efficient pumping system, but if it's pushing against a poorly designed irrigation system, then your pumping costs are still going to be high. And we actually find a lot of the improvements are in the irrigation system. So some of the common causes of high friction loss and total dynamic head, as I said, undersized delivery pipelines or undersized pipelines in the irrigation system itself, high flow rates and system capacities, so trying to push too much water through that irrigation system. I'll go into that in a bit more detail in a sec.

Nick O’Halloran:

Having multiple duty points. So having a pump system that's connected to different irrigation systems, each requiring a different flow rate and a different total dynamic head or total pressure results in higher residual head in some of those irrigation systems. And so that on some parts of the system we can have much higher energy costs than we should have. And that's where variable speed drives come in to reduce that residual head. And we'll talk about that with Sam's system as well.

Nick O’Halloran:

The other common cause of high friction loss is end-guns like this one at the end of the system. They're often considered to be a relatively cheap way of increasing the length of a center pivot or lateral move. There's a booster pump required to help push that water out further. They can throw water up to 40 metres. But in actual fact, we're having to push all of this extra water through the main pipeline and there's extra friction loss there and if the system's not well designed, then that can be a considerable extra energy cost. So designing the system for the end-gun, if you're going to have one, is really important and if it's not designed, it's probably better not to put the end-gun on in the first place.

Nick O’Halloran:

So just a couple of examples of, I guess, the size of the opportunities we've seen to reduce energy costs. One, as I said, is reducing the flow rate through the system. So having an appropriate system capacity of an irrigation system so that the system capacity is the maximum amount of water that can be applied over the entire irrigated area in a 24 hour period; and it is a really important number. You've got to get that right, because if your system capacity's too low, then you can't keep up with crop water demand in the middle of summer and so yields will be compromised. But what we see quite often is system capacities that are higher than necessary. So in Northern Victoria for growing maize and lucerne, a system capacity of around 14 to 15 mls is considered high enough, but we commonly see system capacities up to 18 and 20 millimetres. That's unnecessary.

Nick O’Halloran:

So in this example, we've got a 400 metre centre pivot. That means we're irrigating 50 hectares. If we're applying eight megalitres per hectare per year, we're pumping 400 megalitres through that irrigation system. And here we've got the annual cost of those two systems. So it's exactly the same system, just with pushing different amounts of water through it. It's costing us an extra $4,000 to have that 18 ml system capacity, and that provides no benefit whatsoever. So over a 15 year period, that's costing almost an extra $60,000 in pumping costs. And that's all just because we're trying to push this extra water through the pivot, increasing total dynamic head. And in this case, it's also reducing the efficiency of the pump.

Nick O’Halloran:

So on centre pivots, it's quite easy to change the system capacity. All we need to do is change the nozzle pack, reduce the size of the nozzle pack, which is relatively cheap and we'll have a look at how that's worked with Andrew. You do have to consider how that change in flow rate and pressure will impact on the pump efficiency. In this case, it's improved the pump efficiency, but you need to look into it and make sure that you are going to actually have a positive impact on efficiency as well, or the pump's able to do the new flow rate.

Nick O’Halloran:

The benefits of doing this is higher on big systems. As systems reduce in size, generally they have lower pressures in the first place. But also, you're pumping less water per year so the benefit's not quite as large. In actual fact, on a lot of systems that we go and look at, we find where they're designed with a very high system capacity, the first thing we do is measure pressure at the end of it and we'll find that pressure's low. They're actually not capable of even pushing the water through that system. So by reducing the system capacity, we're reducing operating costs and improving the uniformity of the system so it's a win-win. So I might bring in Andrew at this point. So I might get Andrew, first of all, just to talk a bit about what he does and his irrigation system and how he's used that.

Andrew Murphy:

Hello. Hey, guys.

Nick O’Halloran:

Welcome.

Andrew Murphy:

Thanks there, Nick. Very informative stuff. Yeah, just a little bit about us is, yeah, we're dairy farmers from Kyabram, milking 550 cows and growing corn under our pivot in the summers and cereal and vetch in the winter. And, yeah, we had a very inefficient sprinkler irrigator that just wasn't putting out enough water. And, yeah, we had these really long, hot weeks where we just couldn't get enough water into the ground, basically because we didn't have the pivot to be able to put the water on. And then we did this audit and found that it was costing a lot of money to pump this water, but, yeah, with a very inefficient irrigator.

Nick O’Halloran:

So you had that low system capacity, so a 10 millimetre a day system capacity, which, as I said, we're looking for around that 14 millimetres in Northern Victoria. And so what you were finding, that you couldn't keep up with water demand and it also affected the area that you actually irrigated, is that right?

Andrew Murphy:

Yeah. So the whole pivot come out as 270 degrees and we were only able to put in about 20 hectares max. And, yeah, we still struggled to keep the water up to that just with the 10 ml per day. And even in the hot weathers, it meant we had to run the pivot for five days straight without turning it off. And that led into a lot of issues with running electricity through peak time and really high evaporation. So, yeah, by going to the 15 ml machine has made that a lot easier. You can irrigate off peak and try and avoid the times when it's 40 degrees and blowing wind.

Nick O’Halloran:

So with Andrew's machine, he had that low system capacity, but also it was quite an old system and it actually had an oversized pump. And that was creating very high residual pressure, so the pressure at the end of the system. And it was actually designed that way because the end-gun on that system had no booster pump. And so it needed really high pressure to throw that water out of the end-gun. So obviously designed when electricity was a lot cheaper. And there wasn't much that could be done with the current system. We'll talk about variable frequency drive for slowing pumps down in a second, but Andrew's system didn't have that on it, so there was no opportunity to reduce the pressure at the end. So even by taking the end-gun off, the pressure would just stay the same. The pump was still running at the same speed. It wouldn't change operating costs.

Nick O’Halloran:

So after we did the assessment, the solution was basically to still get rid of that end-gun but increase the system capacity, which sounds ironic, sounds opposite to what I talked about before, but you've really got to have a look at the system and understand how it is operating at the moment and therefore how to change the system. But essentially by increasing the system capacity in this case, we were letting more water out of that system before it got to the end. That reduced the pressure. But also, because his system capacity was so low, it had benefits for the system in terms of, as Andrew said, being able to keep up with crop water demand in the middle of summer. So you've seen a significant drop in energy cost now, Andrew?

Andrew Murphy:

Yeah. Yeah, it's a big difference. I think it's, what, $10 a megalitre or something like that? So, yeah, $50- 60 a day, which is better in my pocket than someone else's. Yeah. It was a bit of a shame to lose the four hectares on the end, but I think we'll probably end up growing the same amount of material or more just by not having that end-gun and having a better machine.

Nick O’Halloran:

Yep, yep. Yeah. So overall, the estimates, the pumping costs went from about using 250 kilowatt-hours per megalitre back to about 200, so about a 20% reduction in energy costs. So it comes out, assuming growing maize under this system, a saving of about $2,600 a year by reducing that total dynamic head. In this particular system, I think there's still opportunities because of that older pump. The pump efficiency is still not over that 70%. So I think there's still opportunities there to perhaps look at the impeller and look at how that pump's actually performing. But a fairly simple cost. What did it actually cost to make that change to the system, change the nozzles?

Andrew Murphy:

Oh, $400. Yeah, pretty minimal. Wasn't much, a bit of labour to change the sprinkler heads. But, yeah, I think our main gains are in the agronomy side of things is what I find.

Nick O’Halloran:

What do you mean by that? In terms of-

Andrew Murphy:

Oh, just getting better yields from what we have. I think it was 2019 our corn crop was only 19 tonnes a hectare or something like that, just because it was so hot and dry. And we just didn't have the ability to get it into the ground, the moisture. Where now we're growing 25, 26 tonne crops consistently.

Nick O’Halloran:

Yep, yep. So, that's the ability to get that water on.

Andrew Murphy:

Yeah, yeah.

Nick O’Halloran:

I think that's a common thing. As I said, focusing on energy, it's a small part of it, but getting the agronomy, getting the right amount of water on at the right time can have huge impacts on, I guess, returns, bigger impacts on returns. So being able to irrigate at the right time-

Andrew Murphy:

Yeah, that's right.

Nick O’Halloran:

... and get the right amount of water is really important.

Andrew Murphy:

Yeah. We can run it just at night or, yeah, run it just at night for seven days as opposed to having run the thing flat out, basically.

Nick O’Halloran:

Yep, yep. Have you put the whole area in?

Andrew Murphy:

Yeah.

Nick O’Halloran:

Yep. And you're able to keep up with that demand now?

Andrew Murphy:

We didn't put the whole area in last year. We have this season. But, yeah, we haven't seen the effects of that yet, so watch and see this year.

Nick O’Halloran:

Yep. All right. Thanks for that.

Andrew Murphy:

Cool. Great, Nick.

Nick O’Halloran:

Unless anything else you wanted to add, we'll move on.

Andrew Murphy:

No, I think that's about all. Thanks very much.

Nick O’Halloran:

Thank you. So I'll just touch on variable speed drives now, also called variable frequency drives. And so for people who don't know what they are, they essentially control the speed of the motor. So this is a variable speed drive here. Without that, the motor runs at a constant speed. It can't be changed. So we can't change the flow rate and pressure on a particular irrigation system. So they're a really good way of managing that residual pressure, reducing the pressure at the end of the system or making sure that the pump's running at the right revs for the system.

Nick O’Halloran:

The only thing is, if your system only has a single duty point, so like with Andrew it's one pivot on that pumping system, requires one flow rate, one pressure, the VFD is unlikely to be beneficial in reducing energy costs. The VFD itself there is inefficiency. It creates a little bit of extra inefficiency itself. So you'll be actually losing some efficiency there. But the better option if you've only got that one duty point is basically to make sure the pump and the impeller's the right size in the first place. And then you don't have the outlay of that extra piece of equipment and the inefficiency through that piece of equipment.

Nick O’Halloran:

Where a VSD is really useful is we've got multiple duty points. So if you've got undulating land, as the travelling irrigator moves over the land, as it irrigates higher land, the pressure it has to push against will increase. And so a VFD could be useful in reducing energy costs there. I'd say in most cases there's probably not enough undulation in Northern Victoria where we are, but other areas there could well be. If you've got multiple irrigators working off one pumping system, then, certainly, a VFD will be useful. And we'll have a look at an example of that. And in horticulture where you've got varying sized or number of valves that you might be irrigating at different times off one pumping system, then having a VFD in that situation can really reduce energy costs. So we might bring Sam in at this point. If you can unmute yourself. Hi, Sam. Welcome.

Sam Thompson:

Hello, everyone. Can you hear me?

Nick O’Halloran:

Yes, can hear you loud and clear.

Sam Thompson:

Okay.

Nick O’Halloran:

So if you want to tell us a bit about yourself first.

Sam Thompson:

Yeah. Thanks for joining in today, everyone. First of all, I'd like to thank you, Nick, and Joe, for taking the time to come out and do an assessment on the irrigators. I had a great day. After the long, protracted lockdowns that we had, it was nice to have some people visit. And I found you guys an absolute wealth of knowledge and I learnt a lot on the day. So for us, our farm is located north of Kyabram. We have a mixed farming operation. And in the application of our irrigators, we focus on high yielding more or less winter crops. Later on, we've introduced the lucerne. So, that was just something that evolved later on.

Sam Thompson:

So the irrigators, they were commissioned in 2015. So we installed two 14 millimetre Zimmatic pivot irrigators, and they were operational in April of 2016. So the business case for them was to initially just augment the production of winter crops, specifically wheat and canola. And like I said earlier, we introduced the lucerne. And overall, I'm extremely happy with the Zimmatic irrigators, and I'm sure Nick will agree. Capacity Irrigation did a great job with the design and the installation of the project. And he's touched on things like variable speed drives and the two duty points that we have for the two machines. They're different sizes. One's 300 metres, the other one's 400 metres. And I find the irrigators or the advantage of the irrigators in our case is that, for me personally, they're controlled through telemetry on the FieldNET app. So in my situation, I can operate the machines anywhere in the world as long as I mobile service or Wi-Fi.

Sam Thompson:

So we're five years down the track now, and so since we commenced the operations. And as most people do in these situations, we felt it was prudent to review the irrigator's efficiency. And we're now considering expanding the lucerne production to the 400 metre irrigator as the 300 metre irrigator ends its production on the lucerne. And so therefore, we needed to make sure the efficiency of the 400 metre machine was going to make it economically viable to go into lucerne. So the points to consider, the questions that we wanted answered from Nick and Joe was, can the irrigator supply enough irrigation water throughout the summer with such a large machine?

Sam Thompson:

I think the irrigation schedule is the utmost priority. I don't want to have to disrupt the irrigation schedule because of energy costs. I try to focus on the crop. And, yeah, so we need to know whether it's going to be economical to run the diesel generator under lucerne in the case of the 400 metre machine. It's working well with a 300 metre machine, but as Nick will point out, we did find some efficiencies there. We've got the additional labour associated with the gen set.

Sam Thompson:

And I guess it's important to understand, initially we went with the gen set option because the system that we put in at the time was self-funded. So we weren't chasing any irrigation grants or anything like that. The project was self-funded, and we really just wanted to get the farm or the block into production. So without going through Powercor, we needed to get the power at least a hundred metres from the existing power that was there on the farm. We just decided to go with the gen set. Because in the case of growing irrigated cereal crops or winter crops, it just wasn't really that critical to have the three-phase mains power.

Sam Thompson:

So, yeah, this is where Nick and Joe had the important role there of coming and making sure they're all running at the optimum performance. I received quite a comprehensive report towards the end of it. And there probably wasn't much we could do with the 400 metre machine. It was running at its maximum capacity, so we couldn't do anything with the pump as such. We couldn't increase the output of the pump. So the end of that machine may need to be valved off, or the end-gun certainly needs to be shut down to grow lucerne. But in the 300 metre machine, which we have the lucerne on, we've got quite a significant residual head pressure. And so we've found some efficiencies by reducing the speed or coming back on the variable speed drive to 80%. And we've achieved around about 15 litres per megalitre per day of diesel by doing that. So from 100% back to 80%, 15 litres per megalitre per day. And it's putting out probably about three, three and a half megalitres a day. So 50 litres of diesel a day, it really does add up with lucerne.

Sam Thompson:

And that machine, I'm not sure if I mentioned, but it's valved off. The last 20 metres of the sprinkler nozzles are valved off because it can't complete a full circle with the fence. And the end-gun has been valved off as well. So, that was probably maybe a reason why that we had the excess residual head pressure in the machine as well. But, yeah, so looking towards the future, we're looking at the three-phase power option. And if that is uneconomical, we may even look at things like a blended power situation with solar and batteries so we can use the existing two phases that are already on the farm, supplied to the farm. We can incorporate a large battery and inverters to make three-phase.

Sam Thompson:

And looking even further into the future, my brother has the adjacent block, so we've got four irrigators on that block, whether we have a small micro array of solar and a virtual power plant. So we're looking at the possibility of peer-to-peer trading of power, so basically becoming a small power provider. But we feel that that may be unlikely because of the voltage problems that are associated with that and the current distributors not being able to balance the grid. So now, I guess the virtual power thing is something that's a long way into the future and probably unlikely. DC may be a little bit clunky. So having the incorporated system but a battery may be a little bit clunky, because I believe there can be some resonance issues with the batteries. So really, I think with the 400 metre machine-

Nick O’Halloran:

Some good options there potentially to look into anyway.

Sam Thompson:

Yeah.

Nick O’Halloran:

Yeah.

Sam Thompson:

Yeah. So I think ultimately with the 400 metre machine, it comes back to if the cost of the three-phase power upgrade is too much, we just won't go into lucerne production. We'll just continue with the business case or the scenario that we currently have with that 400 metre machine.

Nick O’Halloran:

I'll have a look at the cost there. As you said, yeah, just being able to change that, the speed of the pump on that 300 metre, there wasn't any opportunity on the 400 metre, but the speed on the pump, potentially a $3,000 saving there per year. So, yeah, it just shows having those, no opportunity on the 400 metre pivot, but having those two different duty points, really good opportunity.

Nick O’Halloran:

So in terms of one of the main reasons for getting us out there was to look at what the potential saving is of going from the diesel to the three-phase mains power. And we found that, yeah, there were significant savings. Basically because that generator and gen set was pretty underloaded, particularly when it was running the 300 metre pivot. And as you mentioned, you've got the labour savings of actually not having to fill that diesel tank. How often do you fill that when you're irrigating, Sam?

Sam Thompson:

Well, now, after your visit, I'm getting at least 48 to 56 hours out of the gen set now, which has actually been a really good result, not just the savings but also the time of having to go and service the machine. Yeah, we're getting probably 56 hours out of it. So it's quite significant. When we have a cut of lucerne or after a cut of lucerne, we pretty much run the irrigator until we have ground coverage. So we do put a lot of water on. So we are going back to that pump shed quite regularly. And then once we've got that ground cover, we may only need to do one or two irrigations before cutting it again.

Nick O’Halloran:

Righto. We might keep on moving in the interest of getting to the end of this in time. So, yeah, some big saving opportunities there also by converting from diesel to electricity, but you've still got to weigh that up against the cost of connecting that electricity.

Sam Thompson:

Yes. Yeah.

Nick O’Halloran:

So thank you very much for that, Sam.

Sam Thompson:

Thank you.

Nick O’Halloran:

I'll just touch on the Irrigation Energy Calculator that we've developed. At the moment, it's mainly for centre pivots and lateral moves, but we are developing one in collaboration with New South Wales DPI for other irrigation systems. So it's a pretty simple tool. Inputs are relatively simple, just the flow rate of the irrigation system and the length of the machine, the amount of megalitres of water that you use per hectare per year, electricity costs and the measurement that I talked about earlier, the energy use of the system, so kilowatt-hours per megalitre, which you would have to get a measurement for your system. Everything else is really just pressures on the irrigation system. So we need to know pressure at the pump, pressure at the centre of the irrigator and the residual pressure, as well as the pressure rating of the regulators and any static head, so any lift, a change in height of that irrigation system.

Nick O’Halloran:

And so what it's able to calculate is what the current total dynamic head is of that irrigation system, and what it ideally would be for a system of that size and flow rate, and then breaks down to where the issues, where that friction loss is occurring. So in the delivery line, so between the pump and the pivot on this one, we've got almost 16 metres of head loss. We should only be having four metres at that point. So probably opportunities there for an improvement. Could be blocked filters or small pipe or some other constriction in that. Between the pivot and along the pivot itself, there's eight metres of head loss. We'd expect a bit over six metres. So, that's not too bad. Oh, so that delivery line is costing us almost $4,000 a year in pumping costs.

Nick O’Halloran:

The pivot itself, restrictions in the pivots only costing us about $800 a year. And it tells us about the excess pressure at the end. That's costing us $500 a year. So in this system, there's potentially $5,000 worth of excess pumping costs. And add that up over a 15 year period, it's about $80,000. So well worth improving that system. It also tells us what the efficiency of the pump is and what our pumping costs currently are. So just a really simple way of putting some simple numbers in about our irrigation system, working out where the problems are and trying to quantify what that's costing us and whether it's worth changing or improving or not.

Nick O’Halloran:

So finally, things to consider at the design phase. What pipe sizes do we require? There's always that trade off between operating and capital. What system capacity do we require for our area? And make sure we've got a pump that matches the duty point of our irrigation system. Do I need a variable frequency drive? Well, that'll depend on whether we've got multiple duty points or not. And when we're getting quotes, make sure we understand we're comparing quotes, make sure we understand what different suppliers are changing and what impact that's going to have on overall pumping costs.

Nick O’Halloran:

For existing systems, we want to check the pressure at the extremities of the system. If they're too high, that's going to be higher pumping costs. If they're too low, we're going to have uniformity and application costs, application issues. So to understand our energy use, we need to measure the energy consumption and, along with water use, measure the pressure at the pump. We can put that into the calculator and work out potential savings in that irrigation system.

Nick O’Halloran:

So, that's really it. Thanks to our funders, DELWP and the Goulburn Broken CMA and the Energy Smart Farming Project, who has funded us for training, and also to the Ag Vic team who do these assessments with me and the farmers who have participated in the program, particularly Sam and Andrew for their time today. So hopefully, we've got a bit of time for questions, Sarah.

Sarah Clack:

Thanks, Nick. Thank you to Nick, Andrew and Sam today for presenting and sharing with us what they've learnt along the way and the changes that they've made in their systems. It's been fantastic to have all of your input, because it, yeah, just makes it a lot more rounded to get the feedback from both Nick as the service provider as well as the farmers who are using those systems. So we do have a few questions in here and we do have a few minutes to spare before we get to one o'clock as well. So we've had a question come through for you, Nick. "Have you collated and made available findings from the assessments that you have done and the rest of the team have done?"

Nick O’Halloran:

Yeah. We are starting to collate that data. And we haven't published a lot of it yet, although we are publishing a little bit in the IL Conference this year. But, yeah, it's a really good benchmark of how the system's operating at the moment and really good for identifying where those opportunities really are within the industry.

Sarah Clack:

Thanks, Nick. And where would people find the information once it is collated?

Nick O’Halloran:

So as I say, the Irrigation Australia compendium, I guess. So, that's the conference. They'll be reported there and, yes, I guess we probably should look at publishing that data too. Have to take that on notice.

Sarah Clack:

Yep. And also too, there is the Energy Smart Farming extensionAUS page, and there is also an Irrigating Agriculture extensionAUS page as well, where information about energy efficiency and also irrigation are also shared. I've got another question here. "What are some indicative megalitres per hectare water requirements for pasture and crops during different seasons and at different stages of the cropping cycle?"

Nick O’Halloran:

Yeah. So, yeah, that does vary, obviously, depending on the type of crop and the region that you're actually in. For lucerne, it's that eight to 10 megalitres per hectare, majority of that in the summer period, obviously. Spring and autumn is lower. For pastures, it can be a similar water requirement. Maize tends to be a bit lower, between five and seven megalitres, but it does vary. It always does vary depending on the season and the amount of rain we get and how hot and dry the particular season is. But, yeah, for a lot of the crops with spray irrigation, looking at that eight to 10 megalitres annually per hectare per year.

Sarah Clack:

Thanks, Nick. There's a question about Andrew's pivot. "Was there the option to potentially add a booster pump to the end of the pivot to run that end-gun, or was that not a viable option for that system?"

Andrew Murphy:

Do you want me to answer that?

Sarah Clack:

You can, Andrew.

Andrew Murphy:

Yeah, I can answer that. I think it just worked out to be very expensive to get those extra four hectares. It just wasn't worth it, the extra energy and, yeah, the extra costs that was associated with doing that. So we decided not to do it.

Nick O’Halloran:

It's also a hydraulic pivot, so there's no power to the centre of the pivot or to the end of it so you'd have to run power to the centre of the pivot and then along the pivot to run that hydraulic pump. So there'd be significant cost to put a booster pump on that system.

Sarah Clack:

Thank you, Nick and Andrew. And a question for, I'd say this would be for Andrew and Sam, "Are the surface pumps attached to a channel system or a bore?"

Andrew Murphy:

Yeah. So we get ours directly from the channel system. So it's pretty good. You just order it two days out and draw it straight from the channel.

Sarah Clack:

Andrew and Sam?

Sam Thompson:

Yeah, so, similar situation. However, I do have a small pond beside the pump shed, so we weren't, in our case, able to do a direct suction out the channel. We wish we could have, but we haven't been able to do that. But it works well the way it is, that the little pond is the same level as the channel. So it's fail-safe. If the pump was to shut off for any reason, water doesn't go anywhere. So it works all right. But, yeah, our first choice was obviously direct suction out of the irrigation channel.

Sarah Clack:

So this next question is, "Can you compare the use and cost of variable speed drives versus electric motors and gen sets versus diesel motors?"

Nick O’Halloran:

I don't have direct costs. It is difficult because it'll depend on the size of those, all the motors, the size of the system. But, yeah, certainly where you've got electricity connected, just the requirement of an electric motor, perhaps a VSD is probably the lowest capital costs. And there's, you've got the inefficiencies in that diesel motor and the gen set. And often what we see is you also need a soft start or a VFD on that system so that the gen set's got the power for startup on that, the startup of the motor. So look, I haven't got exact costs, but in a lot of cases, if you've got electricity there, the electric motor is a much simpler solution and less capital components required as well.

Sam Thompson:

Yeah. If I can perhaps just say something about that. I think, yeah, if you've got three-phase power available, certainly go to the grid. You'll have less maintenance issues than associated with your diesel generator. But in some cases it may be cost-effective because you don't have to supply three-phase power to the block or to the site. So, yeah, it's just a trade off, I guess. We did it with the diesel gen set. It was a better option at the start. But now, if we're going to go into lucerne and run the irrigator a lot more often, then we really need to go to three-phase mains power.

Nick O’Halloran:

As you said, that gave you the opportunity to get started, get the project up and running, whereas you would've had to wait some time to get that power connected as well, so another thing to consider.

Sam Thompson:

Yes, yeah and also, yeah, it probably would've put additional costs. I know there was cost of putting the generator on, but the additional cost of putting the three-phase power on as well. So they just need to be weighed up.

Sarah Clack:

So the question is, "With NII power, why would you use gen set and electric motor versus a diesel motor and pump?"

Sam Thompson:

If I can just say in the case of my irrigators, they run off three-phase power, so there's no hydraulic system at all. So each wheel has an electric motor so they're all electric. So, we needed a solution to running those irrigators. So, yeah, we had to use a three-phase gen set.

Sarah Clack:

Yeah, so that should have read, "With no power, why would you-"

Sam Thompson:

Yeah. Probably nil power, maybe they were trying to ask that. Yeah.

Sarah Clack:

Possibly, yep.

Sam Thompson:

Yeah. So, yeah, some of them, if they're hydraulic, they may just run with diesel engines, one for the pump and then one out of the centre of the irrigator to run the hydraulic pump for the wheels.

Sarah Clack:

Awesome. Thank you for that. Just like to say a big thank you again to Nick, Andrew and Sam for today.