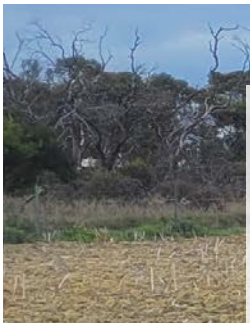

Claying efficiency in the Albany Region

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BACKGROUND

Claying has become a vital amelioration tool in the Great Southern region of WA. It is the process of adding clay enriched (20-50%) subsoil into clay deficient and water repellent topsoils. Local soils are typically sandy, low in organic matter, non-wetting and at risk from wind erosion. Claying has consistently increased grain yields on sandy duplex soils, where the clay is incorporated to at least 30cm, lifting the overall clay content in this crucial area of the soil profile.

Claying topsoils reduces water repellence, increases water & nutrient holding capacity, and has the potential to increase organic matter over time. On sandy soils the economic outlay can be overcome within a couple of seasons due to the significant increase in yields. This, coupled with the long-lasting efficacy (30+ years), has made claying a widespread activity irrespective of the economic outlay.

The cost of claying has traditionally dictated the rate at which clay is spread. The general rule that local growers follow is that 'more is better', up until a point where too much clay can be problematic to incorporate. DPIRD researcher David Hall & colleagues have previously determined that growers should aim for 5% clay content in the soil to alleviate non-wetting and improve water and nutrient holding capacity. Clay spreading costs anywhere between $500-$1500/Ha, making it logical to calculate the exact amount needed on each paddock. Given the sizeable economic outlay of claying, it is surprising how much guesswork is involved in the decision-making process.

CALCULATING CLAYING RATES

The best practice for alleviating non-wetting and repellence issues is to target a clay fraction of 5% clay in the topsoil. However, there are quite a few variables that impact the ability of a grower to achieve this benchmark. Firstly, it is unlikely that a paddock has a consistent soil type, let alone a consistent soil texture. To establish how much clay a grower should spread, you need to know three key details:

1. What is the current clay percentage in the soil?
2. What is the clay percentage in the product you plan to spread?
3. What depth will you incorporate the clay in the soil?

To determine the target soil's clay percentage, soil samples from a representative area in the paddock are required and should be taken to the planned depth of clay incorporation. Ideally, growers would take multiple soil samples within the paddock at different depths to the target incorporation depth.

The depth to which clay is incorporated will be dependent on the implement being used to spread and incorporate. A deep ripper with inclusion plates can incorporate clay to 60cm, while a speed tiller will incorporate clay to 15cm. Picking an implement that will suit the target depth and clay rate is essential, as this will affect how much clay needs to be applied to reach the target percentage. It will take a significantly lower application rate to bring a topsoil clay percentage of 2% to 5% when incorporating to 15cm compared to 50cm. There is no standard amount of clay needed to shift a soil from 2% to 5% clay content because not all clays are created equal.

The clay pit which the subsoil clay is taken from is usually selected for logistical reasons, such as proximity to the targeted area in the paddock. The quality of the clay is not known until the topsoil and gravel has been removed and the clay exposed. Given the cost of doing this, the grower is usually obligated to use the clay on offer. Clay fractions can vary from 10-50%, and this has a significant influence on how much clay needs to be applied. Testing the clay before spreading is critical if 5% clay content is to be achieved because it is difficult to determine the quality of clay by sight and feel. The clay fraction can easily be determined via the soil testing services provided by Summit and CSBP. This project aims to help SCF members determine how much clay they should be spreading on their paddocks to suit their goals.

$$\text{Clay (t/ha) to reach 5\% topsoil clay} = \frac{-(10{,}000\times1.5\times1.4\times ID\times(TC-CC))}{((20-100)\times(100\times CP\times1.5-ID\times(TC-CC)\times1.5-1.4)))}$$

EXAMPLE: A SANDY PADDOCK WITH SEVERE NON-WETTING ISSUE

Topsoil (0-10cm) clay percentage is 1.2%

10-30cm horizon clay percentage is 1.8%

The average clay % on the top 30cm of this soil is 1.6%

The soil is a shallow sandy duplex, with a clay layer between 40-50cm. The grower plans to use a Plozza plough to incorporate the clay because that is what they have access too.

The next thing we need to know is the clay fraction (that is the amount of clay in the "clay", you wish to spread). The clay pit location has been chosen by the contractor based on their assessment of the most efficient strategy to spread clay in this paddock.

After the pit has been 'opened up', the grower will need to take some representative clay samples, this will require digging deeper into the pit, as the clay quality will change with depth. If there are major differences in clay percentage within the pit, this will affect the amount required to achieve a 5% clay percentage in the target soil.

Once this is done, samples of the clay need to be sent to CSBP or Summit laboratories for testing. Testing the product will provide information on any potential nutrient toxicity issues, or how the clay may change soil interaction with applied nutrients (e.g. changing the phosphorus buffering index (PBI). The clay analysis will show how much "clay" is in the sample, along with the silt and sand content.

In this example the clay has a 'clay' percentage of 28% and a silt percentage of 5% with no nutrient toxicity issues to worry about. Now for the million-dollar question, how much of this stuff should we be putting on?

The soil has an average of 1.6% clay in the top 30cm, and the soil test showed a 2% silt content, leaving a sand content of 96.4%.

Assume that the bulk density of the topsoil is 1.4%, the bulk density of the clay/silt is 1.5%, and the moisture content of the clay is 20%.

In which case, 100t/ha of "clay" will equal 8kg/m2 of soil added, and of this soil 2.24kg/m2 (8x 0.28) of clay and 0.48kg/m2 (8x 0.05) of silt will be added.

Using the below formula, the amount of clay that is needing to be applied to lift the top soil from 1.6 to 5% clay can now be calculated.

Clay (t/ha) to reach 5% topsoil clay = (-(10,000×1.5×1.4×ID×(TC-CC)))/(((20-100)×(100×CP×1.5-ID×(TC-CC)×1.5-1.4))))

Where:

ID = incorporation depth (mm)

TC = Target topsoil clay percentage

CC = Current topsoil clay percentage

CP = Clay percentage of "clay"

650t/ha is requiredand this would be considered a heavy application rate.

It is the interaction of the three key factors; current clay fraction of the target soil, the clay content of the "clay" being applied, and the incorporation depth that will dictate how much material will need to be applied.

For example, if clay percentage of applied "clay" was 38% rather than the 28% used in the example above, 475t/ha would be required to reach the target clay percentage of 5% to a depth of 300mm. If a speed tiller is the implement available for incorporation and as a result an incorporation depth of 15cm is all that can be reached, then this would further reduce the targeted clay rate to achieve the 5% clay percentage to 235t/ha. This demonstrates the interlinked nature of these key variables, and how they should be considered in combination with each other.

SCF DEMONSTRATION

The SCF demonstration site at Kojaneerup South, had three distinct claying application rates of 350, 270 and 140t/ha, with incorporation by offset discs to approximately 15cm. Although this depth is relatively shallow, the target constraint within this paddock is non-wetting soils, and the vast majority of the repellent properties lie within the top 15cm of the soil profile.

Results

Clay samples were taken from the clay pit on site, and the applied clay had an average clay fraction of 40.4%. Soil samples from the topsoil of the target paddock revealed that the current clay percentage is 1.7%.

All three clay rates significantly shifted the topsoil clay percentage (Table 1), with only the lightest application rate failing to achieve the targeted clay rate of 5%. The other two rates exceeded the best practice percentage of 5%. These results highlight the ability to vastly shift the clay percentage in topsoils when using a highly enriched clay source and a relatively shallow incorporation depth. While the 270t/ha and the 350t/ha ameliorated soils are above the 5% target, it is unlikely that this over application will result in any adverse effects, given the best practice target rate is often as high as 7% for soils with a high level of organic matter.

The results highlight the potential efficiency and productivity savings that can be realised when clay content is known before spreading. Unlike a lot of other agronomic inputs that can be dialled in on a precision level, productivity in clay spreading is largely dictated by the carrying capacity of the machines, the speed in which they spread clay, and the width of the machine. The machine used at Kojaneerup South could spread clay anywhere between <100t/ha and 270 t/ha per pass, depending on the speed the machine was traveling. To spread at higher rates, more than one pass would be required.

Incorporation depths

Table 1: The predicted clay percentage in the top 15cm at the Kojanerup South claying efficiency demonstration site in 2022.

Clay application rate	350t/ha	270t/ha	140t/ha
Ameliorated topsoil clay %, incorporated to 15cm	7.0%	5.8%	3.8%
Change in topsoil clay %	5.3%	4.1%	2.1%

The fixed nature of the variables involved in clay spreading (clay fraction, topsoil texture, available spreading rates) limit what a grower can control. The fixed variables as well as the target soil constraint need to be considered when choosing incorporation implements and depth. For example, to solve a water repellence issue like the trial site at Kojaneerup South, a shallower incorporation method such as an offset disc, or speed tiller can be used. However, if targeting non wetting, plus eliminating soil erosion and improving soil water holding capacity, then a different implement will be needed to incorporate the clay deeper. For example a Plozza plough or a deep ripper. The incorporation depth will dictate the amount of clay a grower needs to spread to reach a 5% topsoil clay content.

A Plozza plough can incorporate clay to approximately 30cm while a deep ripper can incorporate clay to approximately to 50cm with inclusion plates. Using the soil parameters and claying rates at Kojaneerup South as an example, there are enormous differences of clay required (t/ha) depending on the depth of incorporation (Table 2).

This emphasises the value in having a clear understanding of exactly what you are trying to achieve before taking on a large-scale claying project. The above results show that the application rates needed to achieve the 5% targeted clay rate varies greatly depending on the incorporation depth. The machine used at Kojaneerup South to spread the clay might not be the most efficient choice if you were targeting a deeper incorporation depth, so consideration must also be given to the type of machine suited to the constraints you are targeting.

APPLICATION METHODS

SCF have observed three different methods of applying clay to sandy soils. Each method has it's specific positives and negatives. One of the critical project findings has been that the current estimation of clay spreading rates is highly variable and based mainly on guesswork by growers and contractors.

Table 2: Changes in the soil clay percentage at different clay spreading rates (t/ha) when incorporated to soil depths of 30cm and 50cm. The red numbers represent the calculated amount of clay (t/ha) required to reach 5% topsoil clay from the two incorporation depths. The black numbers represent the actual clay rates spread at the Kojaneerup South demonstration site. NB: This table assumes the 1.7% clay rate measured in the top 15cm of the soil profile at Kojaneerup South is consistent to the max incorporation depth.

Clay incorporation method & depth (mm)	735T/ha	436T/ha	350T/ha	270T/ha	140T/ha
The topsoil clay % when incorporated to 30cm with a Plozza plough.	7.2%	5.0%	4.4%	3.8%	2.8%
The topsoil clay % when incorporated to 50cm with a deep ripper & inclusion plates.	5.0%	3.7%	3.3%	2.9%	2.3%

Self-Propelled scraper

A scraper was used to apply clay on Ben Webb's property at Scott's Brook (Southern Dirt), where the initial target rate was 250kg/ha. However, the scraper could not apply clay at this rate, because the speed limitations of the machine dictated the rate at which the clay was applied. Whilst the machine could be slowed down to increase the rate, the maximum ground speed sets the minimum application rate. The lowest rate we could apply on Ben Webb's property was approximately 400t/ha. This machine may not be suitable for farmers seeking to apply a low rate to achieve 5% clay content in the topsoil or where the incorporation depth will be shallow.

The advantage of the clay scraper is the high payload of >45t/ha and the relatively even spread of the product on the paddock. The cost of such a machine may also be lower on a per hectare basis than a carry grader or a Nufab 'Spreadit' machine.

Figure 1: Self-propelled scraper

Carry Grader

A carry grader is commonly used in the SCF region by contractors and growers. The positives of a carry grader are the speed of loading and speed of unloading. The clay spreading rate can be adjusted relatively easily by an experienced operator. A carry grader can also get in and out of the pit very quickly, spreading many tonnes of clay per hour. Carry graders can also use their own rippers to break up the clay before loading, which means you can complete the whole process without needing additional machinery. The downside is the lumpy nature of the clay being spread, although this varies significantly with the type and quality of the product applied. The method of re-distributing and incorporating the clay is critical and should complement the use of a carry grader, or any other machine. A carry grader requires a high powered 4WD tractor to pull the machine, and wear and tear is costly, either for the contractor you hire or for a grower's own machine.

Figure 2: Carry Grader

Nufab' SPREADIT'

This new machine was recently purchased by SCF members Josh & Tony Goad. The machines are common in other areas of WA, but this is the first machine to be used in the local area. The 'Spreadit' machine is designed like an oversized fertiliser spreader that is loaded via an excavator. The positive for this machine is that it spreads very evenly and can reduce its rate per hectare lower than a carry grader. This machine is more suited to growers wanting to apply rates closer to 100t/ha. Incorporation costs are also likely to be lower after using the SPREADIT because of the lower clay rate the even spread pattern.

Another positive is that the machine is easier to pull with a 4WD tractor and will likely have less wear and tear on the tractor over time. The machine requires less experience and skill to operate than a scraper or carry grader, which means labour to operate the machine will be more accessible. The negatives are that it requires an excavator to load, and loading time compared to a carry grader is much longer. We look forward to understanding more about this 'new' machine's positives and negatives over the course of this project.

Figure 3: Nufab 'SPREADIT'

FINAL NOTE:

During this early stage of the project, we are assuming that the yield benefits from clay spreading are maximised when the soil reaches a 5% clay content to the incorporated depth. At the Kojaneerup South demonstration site two of the three treatments exceed 5% clay at the incorporated depth of 15cm. We look forward to measuring the yield results from the clay treatments over the next two seasons. Anecdotal evidence from local growers would suggest that the highest clay rate at the demonstration site will have the highest grain yield. Research by David Hall (DPIRD) suggests that achieving 5% clay in the topsoil is sufficient to maximise yields and applying more than that is not economical.

ACKNOWLEDGEMENT:

We would like to acknowledge the previous research conducted by David Hall and other DPIRD researchers on 'clay spreading' as a soil amelioration strategy. We look forward to hosting a workshop in early 2023 where we will hear more from David and his experience in the Esperance Port Zone. We also thank David for providing SCF with the DPIRD "clay calculator" (Excel model) which allowed us to run the calculations.