Soil amelioration paper appendices

# Appendix: categorisation of agricultural commodities

Livestock grazing and field crops tend to take up large areas of land, with more than 80% of municipal surface area being taken up by grazing in some instances. When looking at the absolute surface area that is taken up by an agricultural activity the anomaly arises that larger municipalities appear more productive simply because they occupy larger land areas. This means that smaller municipalities do not show up in the analysis, despite having a larger percentage of their land surface area used in agriculture. To correct for this phenomenon, both livestock grazing and field crops are reported in hectares of agricultural activity per hectares of municipal land.

Horticultural areas, on the other hand, tend to be much smaller and more concentrated than either grazing or field crops, so larger municipalities do not necessarily have an advantage over smaller ones and normalising the data makes the numbers to work with very small. For example: the horticultural regions towards the west of the country are concentrated around the Orange river and cover a very small percentage of the total land area used (0.4 % in Kai! Garib municipality, 0.1% in Dawid Kruiper municipality) (data in the companion spreadsheet called *Agricultural Statistics for South Africa* in the tab called *2017 Detailed commodity stats*). Horticultural area is therefore reported in hectares, not hectares relative to municipal surface area.

Each agricultural commodity class has its own categorisation ranges. This is because the area used for grazing is much larger than that of field crops, which in turn is much larger than the land areas used for horticulture. The ranges were chosen such that they are regular and split the municipalities into meaningful groups. Since most of the soils of interest are in the Northern Cape province, field crop ranges start relatively small to include some of the important Northern Cape field crop growing regions in the analysis. Municipal land area used for grazing tends to be relatively large across the board, so the categorisation ranges for grazing started with relatively high numbers, to include only municipalities with significant grazing.

# Appendix: Assessing average farm size

The average sizes of farms in different agricultural commodity classes are subjects of interest, since knowing that would allow a calculation of what the average transport cost of applying sulfide-enriched material will be in each commodity class. Livestock grazing tends to occupy larger land areas in most municipalities than field crops and horticulture, so it would seem reasonable to believe that livestock farms are bigger and horticultural farms, occupying the smallest area of the agricultural commodity classes, the smallest. For reasons that will now be explained, confirming this by calculation could not be done with data from statistics South Africa’s Census of Commercial Agriculture that was published in 2020 (Statistics South Africa, 2020).

Firstly, these numbers are not directly reported. Statistics South Africa defined the ‘size’ of a farm in economic terms (eg. a ‘large’ farm is one with an annual income of more than R22.5m) and the word search ‘area’ did not show any results. They did give data for land use per commodity class (e.g. 1,000,000 ha in the Western Cape is arable land), but do not present the number of farming units per commodity class as well, so one cannot calculate the average farm surface area in each commodity class. Also, from their presentation, it appears that more and more farmers are engaging in ‘mixed’ agriculture – growing crops and tending livestock at the same time, which will complicate such a calculation if it were undertaken. All the municipalities have a mix of agricultural activities, so it is impossible to guess at what the spread of farming units is between those activities. To complicate matters further, looking at the average farm sizes per municipality showed that Northern Cape farms are on average bigger than Limpopo or even Free State farms, regardless of their commodity. I didn’t find data on farm sizes per commodity or area or even commercial vs small scale farming. Even a PhD thesis on the progression of agriculture in South Africa only gave a country-wide average (Liebenberg, 2013).

I therefore calculated only the average farm size per municipality, taking the sum of the land areas occupied by different agricultural commodity classes and dividing that by the number of farming units in that municipality. These average numbers were then averaged to find the average farm size in the agricultural regions of interest.

# Appendix: Costing assumptions

#### Road transport costs in South Africa

The cost of road transport of a product depends on its mass as well as the distance that it has to travel and is therefore normally quoted in R/t-km (Braun and Van Zyl, 2012; Simpson, 2013). This assumes that the transport vessel is filled to capacity. Should a truck be loaded with a lower mass than its design specifies, the cost per tonne-km will be higher than this estimate due to inefficient use. By extension, whether trucks are full on the away and return legs of a trip influences the transport cost significantly. The use of a vehicle that only carries load on one leg of a trip will cost roughly double that of one that is used on both legs (Braun and Van Zyl, 2012), depending on the arrangement with the truck contractor. Lastly, the type of truck used will also affect the transport costs. The most likely transport vehicle will be a 7-axle interlink truck, since it can carry large loads efficiently (Braun, 2019). Using the 50% utilisation figure (R 1.28 /t-km) was considered conservative, since the sulfide-enriched material will not be transported in the same manner as the food products that farmers produce, and trucks are therefore likely to return empty, unless nearby mines (such as manganese mines in the Northern Cape) will agree to fill the trucks on the return leg and share logistics costs. This would materially reduce the cost of transport.

The March 2019 Fleetwatch numbers for a 7-axle interlink truck indicated that transport would cost around R 1.28/t-km if the truck is empty on the return trip or R 0.64 /t-km if the truck is filled in both directions (Braun, 2019). These numbers are significantly higher than Viljoen et al.’s (2015) April number of R 0.39 /t-km for a full truck, given that inflation calculated with the South African Reserve Bank’s consumer price index (CPI) figures would have increased the price to R 0.47 /t-km (South African Reserve Bank, 2019). The increase in fuel price is similar to the CPI figures, so the increased cost cannot be ascribed to an outsized increase in fuel prices. The price increase might be due to South Africa’s deteriorating road infrastructure (Viljoen et al., 2015) and concomitant increased truck maintenance costs or more regular truck replacement costs.

#### Competitor product price

Pyrite works by spot reducing the pH of alkaline soils, improving nutrient availability and releasing iron and sulfur as nutrients. It also works by dissolving calcite inherent in sodic soils, thereby releasing calcium ions and replacing some of the sodium ions adsorbed on clay particles. This improves soils’ structure. The products that are competitors therefore either reduce pH, add nutrients or improve structure by the addition of calcium ions, mostly in to form of gypsum. Gypsum was chosen as the competitor product to compare prices with in this analysis, since it is also a bulk mineral commodity used for soil amelioration.

Gypsum to the Northern Cape will most likely be supplied from Phokeng, near Rustenburg, since it is better priced at R 235 /t than the Potchefstroom gypsum at R 360 /t (Kalkor (Pty) Ltd, 2019). In Mpumalanga gypsum is supplied from Middelburg at R 240 /t, while in Limpopo gypsum is supplied from Phalaborwa at R 190 /t (Kalkor (Pty) Ltd, 2019). Chloorkop supplies Gauteng at R 315 /t (Kalkor (Pty) Ltd, 2019). Other gypsum suppliers did not respond to requests for quotes.