1. Introduction and background

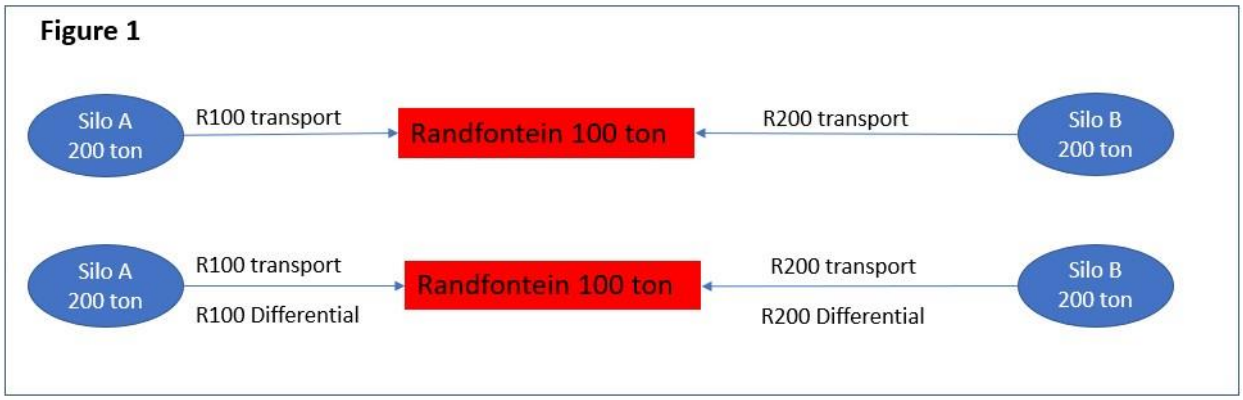
The 2019 report by Prof. Matt Roberts supported the continued application of location differentials as an integral part of the physical settlement of futures contracts. He also identified certain challenges facing the JSE agricultural derivatives system. These challenges include an operating environment with market concentration and limited transparent cash prices. The JSE is addressing the latter with the spot basis window (SBW) system, but participation levels are, at this stage, not fully representative. Other challenges mentioned by Prof Roberts are a high redelivery rate at some silos, as well as the absence of a par delivery zone. The South African agricultural market also has its own challenges, one of these is the finance structure of production. The majority of the crop is financed through production finance, which limits to a large extent, the utilization of premiums. In essence the largest part of the crop is financed using the floor price of JSE(Safex) Price-Location Differential as benchmark.

With this context, the following information aims to present an alternative methodology to replace the single reference point principle for the JSE commodity derivative contracts. This methodology presents an enhancement of the process to determine the location differentials applicable to delivery points in completion of a futures contract by considering the supply and demand of the commodity.

1.1. The importance of location differentials

When the agricultural futures market was established in South Africa, the approach by the then South African Futures exchange was to include as many delivery points as possible that met the Safex requirements. This enabled physical delivery in completion of a futures contract and largely facilitated price convergence between the spot market and derivatives market. Although the key role of a derivatives contract is focused around price risk management, the ability to make or take physical delivery in an efficient and robust manner does contribute to a successful derivatives contract. A single reference point was selected, namely Randfontein, from which the derivative contracts would be referenced whilst delivery would be recognized at various points across the country. Should physical delivery be made to complete the futures obligation, a transport discount was applied to ensure price indifference. This transport discount or location differential was the component that enabled delivery from any registered delivery point across the country whilst a single derivatives contract could be traded.

Although each Safex registered delivery point was allocated a location differential to align deliveries to Randfontein, it was expected the spot market would evolve and more accurately reflect the unique supply and demand pricing factors for each geographic point, resulting in a diminishing role of the Safex reference price less location differential as a floor price for the spot market. The challenge as we have seen over the years is that the spot market has not matured as expected and so the economic value of each geographic point is not always transparent to everyone. This concept of the differential is illustrated in Figure 1 in a simplified format using soybeans as an example.



It is clear from the first part of **Figure 1** that Silo A and Silo B have different economic values with regards to Randfontein. As each of the silos has enough stock to supply Randfontein, all soybeans will be sourced from the substantially cheaper Silo A. As a registered delivery point, Silo B will still be able to "sell" it to the exchange, which will assign the JSE silo receipts to the Randfontein long position holders. The buyers will simply redeliver it to the exchange, because of Silo B's unfavourable location. This redelivery cycle will be repeated over and over should no location differentials exist, as there is no recognition of the different economic values of Silo A and Silo B. This exact situation was demonstrated in the JSE deliverable soya bean contract previously when no location differentials where applied.

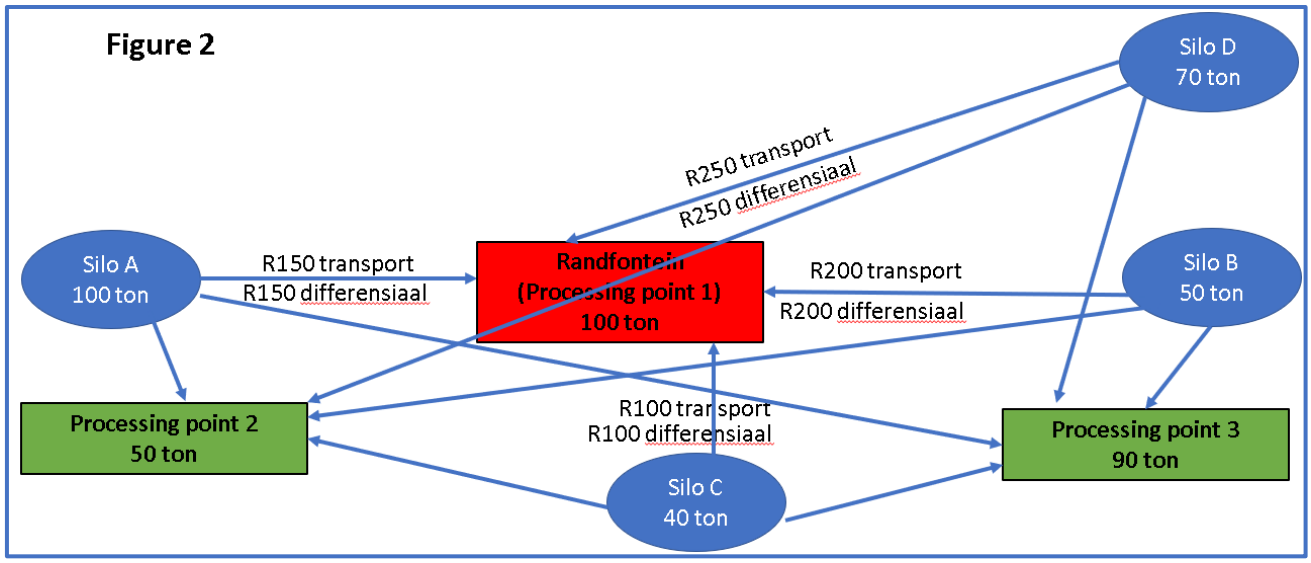
In the second part of Figure 1, the introduction of location differentials provides a discount of R100 for Silo A receipts and a R200 discount for Silo B receipts. Randfontein buyers will now be **price indifferent** to the two silos, with no excessive redeliveries expected.

It is important to note should any structural changes be made to derivative contracts, these will only be adopted for a new marketing season where there are no existing open futures positions. This also makes it difficult to present an exact impact analysis regarding the proposed changes due to the future implementation date.

1.2. The reality of multiple processing points

The share of Randfontein as a processing hub has declined steadily over time for all grains and oilseeds. In the case of soybeans, only an estimated 10% to 15% of processing capacity is situated in Randfontein itself. The determination of location differentials that ensures price indifference had become more and more complex.

The reality of multiple processing locations and the difficulty of getting correct transport cost figures led to a situation shown in **Figure 2**, again in simplified format.



The example in Figure 2 represents 4 silos as supply locations, with 3 processing points as demand locations. Determining the economic value, or price indifference discount for each silo seems difficult. For the 2022/23 season, 10 soybean processing points has to get stock from 200 JSE registered silos. Determining the correct location differentials for 200 silos with just transport costs as criteria will be nearly impossible. Figure 3 further illustrates the problem.

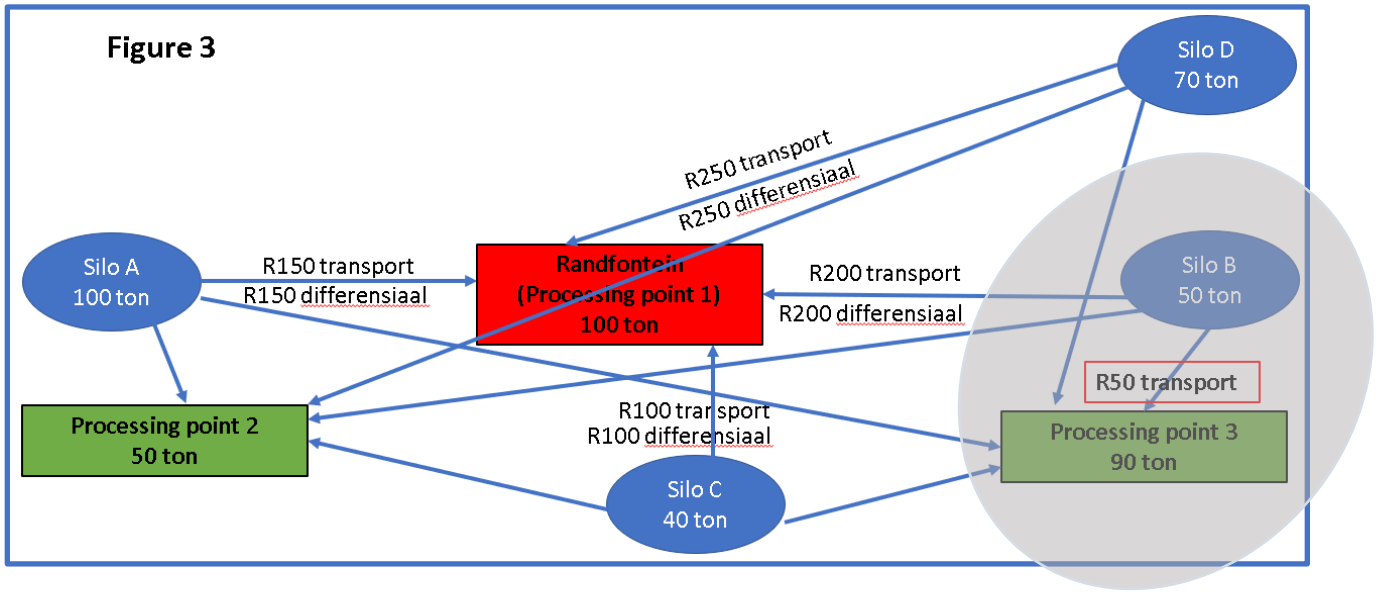


Figure 3 is basically the same as Figure 2, but focusing on Silo B and Processing point 3. Processing point 3 has an annual capacity of 90 tons, with available stock at Silo B (the closest silo) at 50 tons. Processing point 3 will therefore, with relative certainty, pay a premium to get stock at Silo B. The size of the premium is generally not well known, because of market power, as described by Prof Roberts. The premium size can be anything from R1 to even more than R200 (the official location differential). Whilst the current

location differential methodology only considers transport costs and does not include the various points of demand, this will continue to acerbate the challenge of determining effective location differentials. This can cause convergence problems, which can ultimately lead to ineffective risk management, the most basic aim of any exchange.

To more accurately reflect the spot market pricing dynamics, why not include in the location differential methodology all processing points, thus bringing their influence on each other into account. Recognizing fluctuating supply- and demand levels will also improve the location differential methodology.

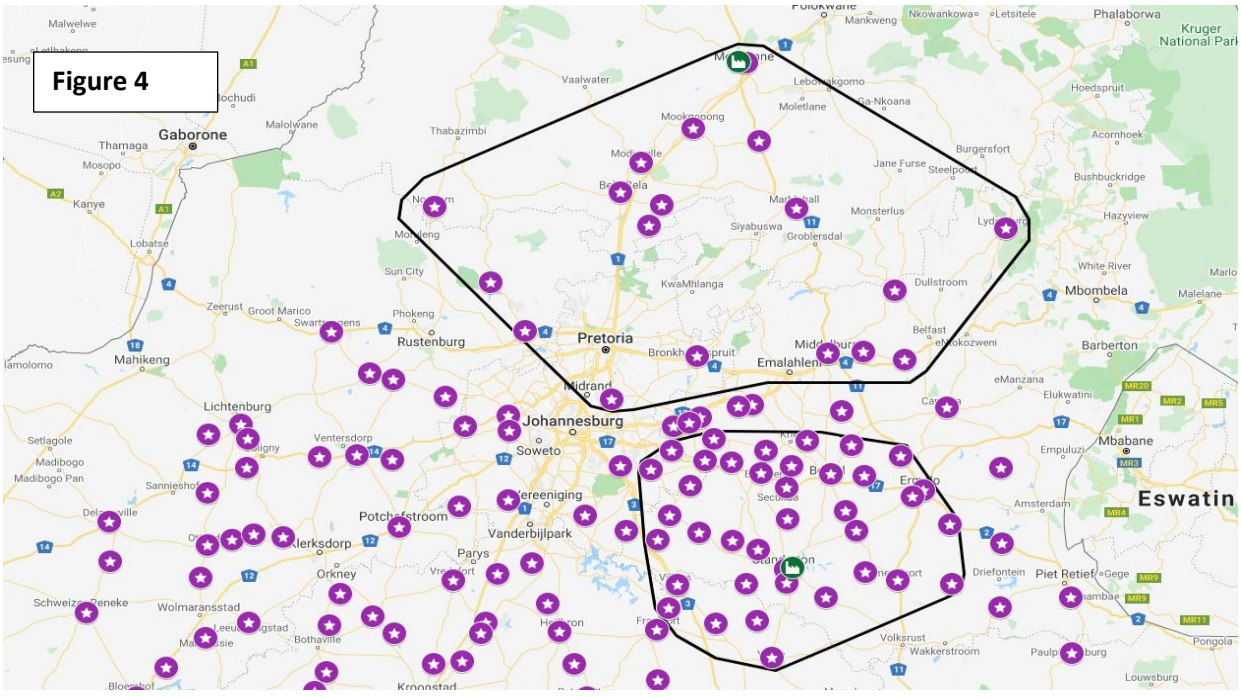
2. South African location differential research

Local location differential research has demonstrated that most of these issues can be accommodated with an alternative methodology to determine location differentials. The proposed system is based on the spatial supply and demand of the product and very importantly, takes into consideration all points of processing and the impact this will have on demand for product from each JSE registered delivery point.

By considering all this information and using linear programming, the methodology is able to construct location differentials, including a zero-differential area, across multiple processing points. There is no longer a requirement for a single reference point of demand as all points are included in the new methodology. Furthermore, the system also has a dynamic component, accommodating possible changes in the market structure of the product. Market power is, to some extent, neutralized by location differentials that reflect actual cash prices more accurately. The functioning of the system and improved methodology will be explained in the following paragraphs.

2.1. Two processing plants example

If there was, for example, only two soybean processing plants in South Africa, one in Mokopane and one in Standerton, their respective supply points can be seen in **Figure 4** (supply and demand quantities for the 2019/20 season).

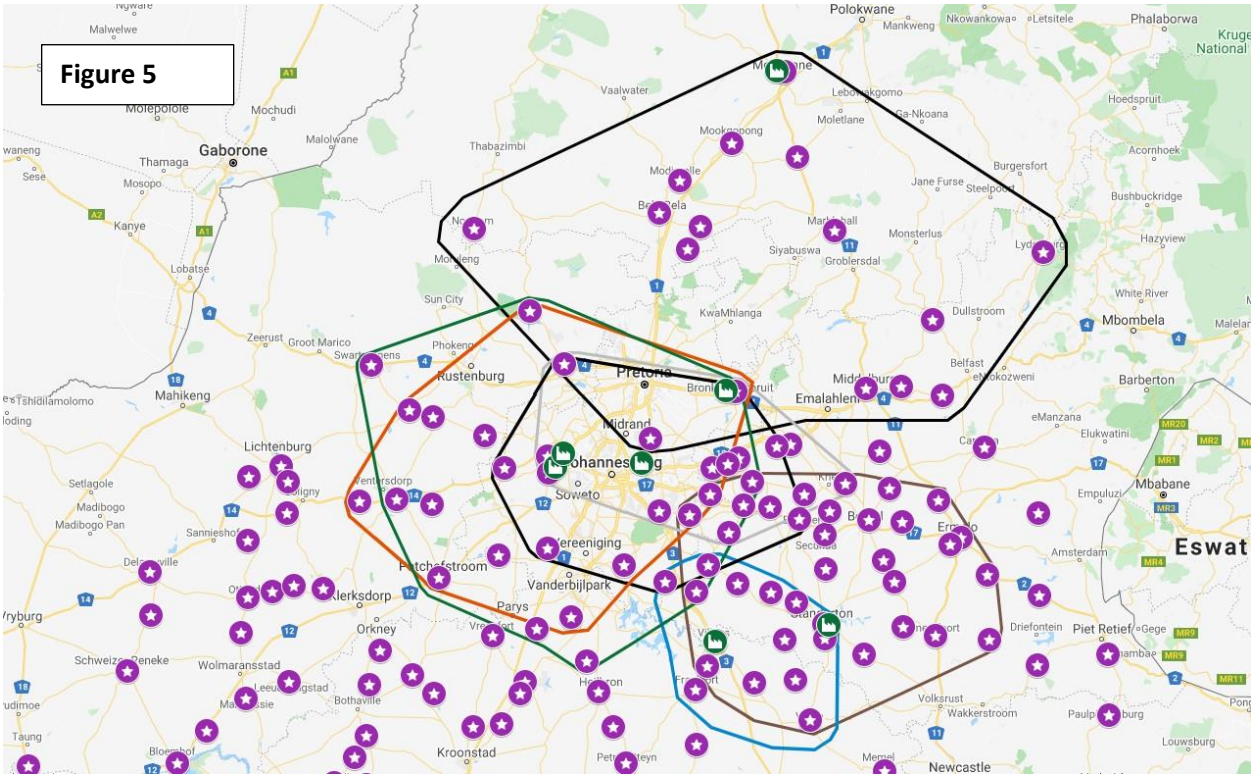


The purple stars in Figure 4 represent registered soybean delivery points and the two green factory symbols the processing plants. The stars inside each polygon are the lowest cost silos for the two plants to get their yearly stocks from. The combined stock from the silos inside each polygon is equal to the demand for each processing point.

The silos inside the polygons will not need a location differential because all redeliveries from them will be accepted at some time by either the Standerton or the Mokopane plant to fulfil their demand criteria. The silos outside the polygons will all need a location differential to recognize the fact that these points are outside the demand area. This will avoid excessive redeliveries from these sites.

2.2 Multiple processing plants

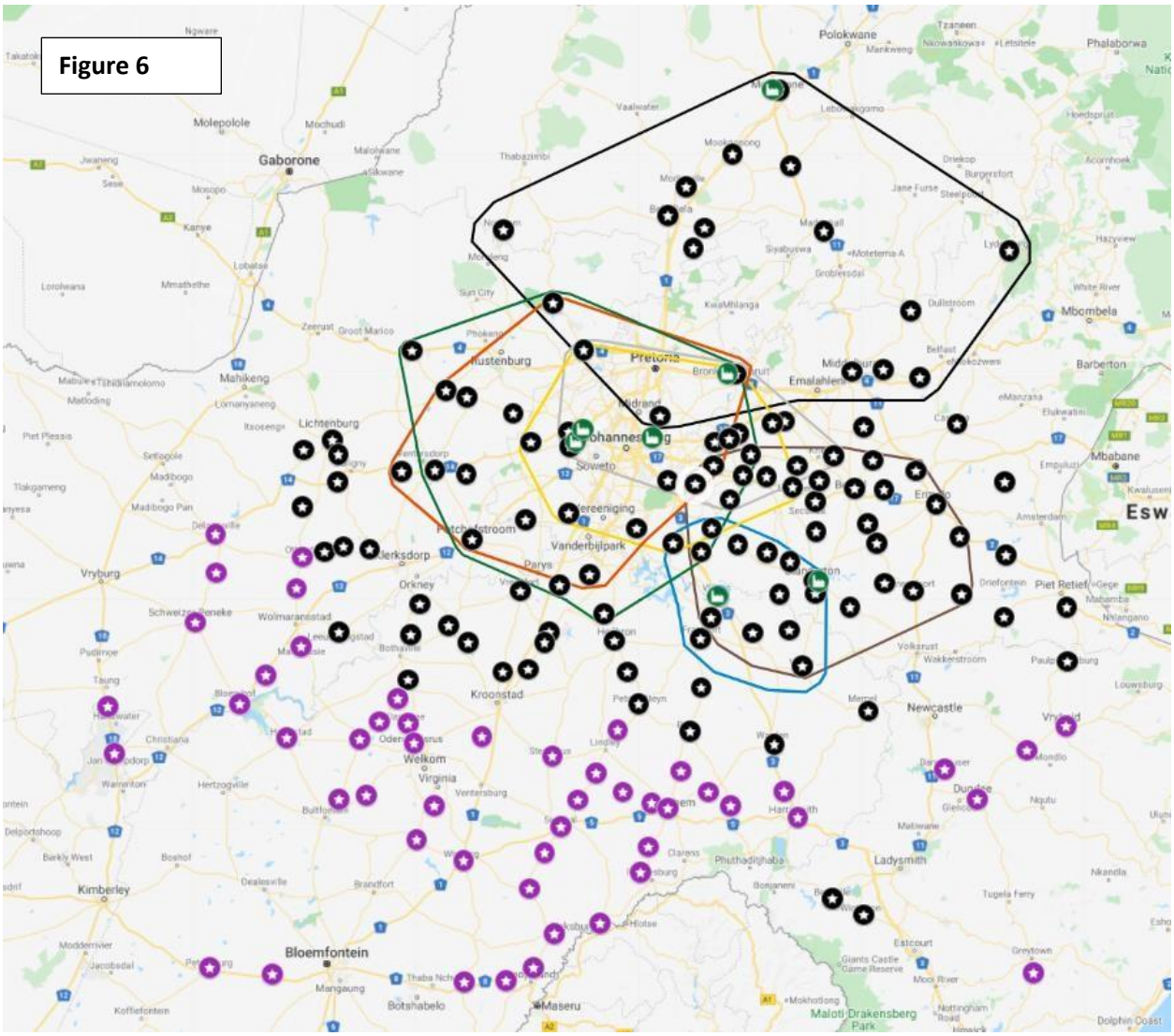
The reality of soybean processing in South Africa is that there are 10 facilities that can be supplied by 200 different soybean silos. These plants, together with their optimal procurement silos can be seen in Figure 5 (Winterton is excluded because of an image space constraint).



It is clear from **Figure 5** that there are a large number of silos which are optimal for more than one processing point. This implies that silos outside of the polygons will also be utilized to supply the needed soybean tonnage while others will still be left unutilized. The question now is: Which silos will not be utilized and will therefore require a location differential in order to be price indifferent? Although the answer can, in theory, be calculated by hand, millions of combinations must be tested before a solution

will be reached where every processing plant have adequate supplies while keeping overall procurement costs at an optimum level.

This can however relatively easily be done by a modelling technique called linear programming, where a computer will weigh all the combinations in a short time and then produce an optimal answer. The answer provided by applying linear programming to the problem is a close approximation of real-world procurement decisions. Figure 6 illustrates which registered silos will be utilized and which registered silos will have redelivery problems without location differentials.



The JSE registered soybean silos in Figure 6 is divided into black stars and purple stars. The black stars are silos that will be utilized without location differentials due to their proximity to the processing plants,

while the purple silos will require a location differential adjustment to be price indifferent. The linear programming model then calculate the size of the location differential required at each purple silo for price indifference.

Before calculating the value of the location differential at each silo, it is important to explain the relationship between price indifference and time.

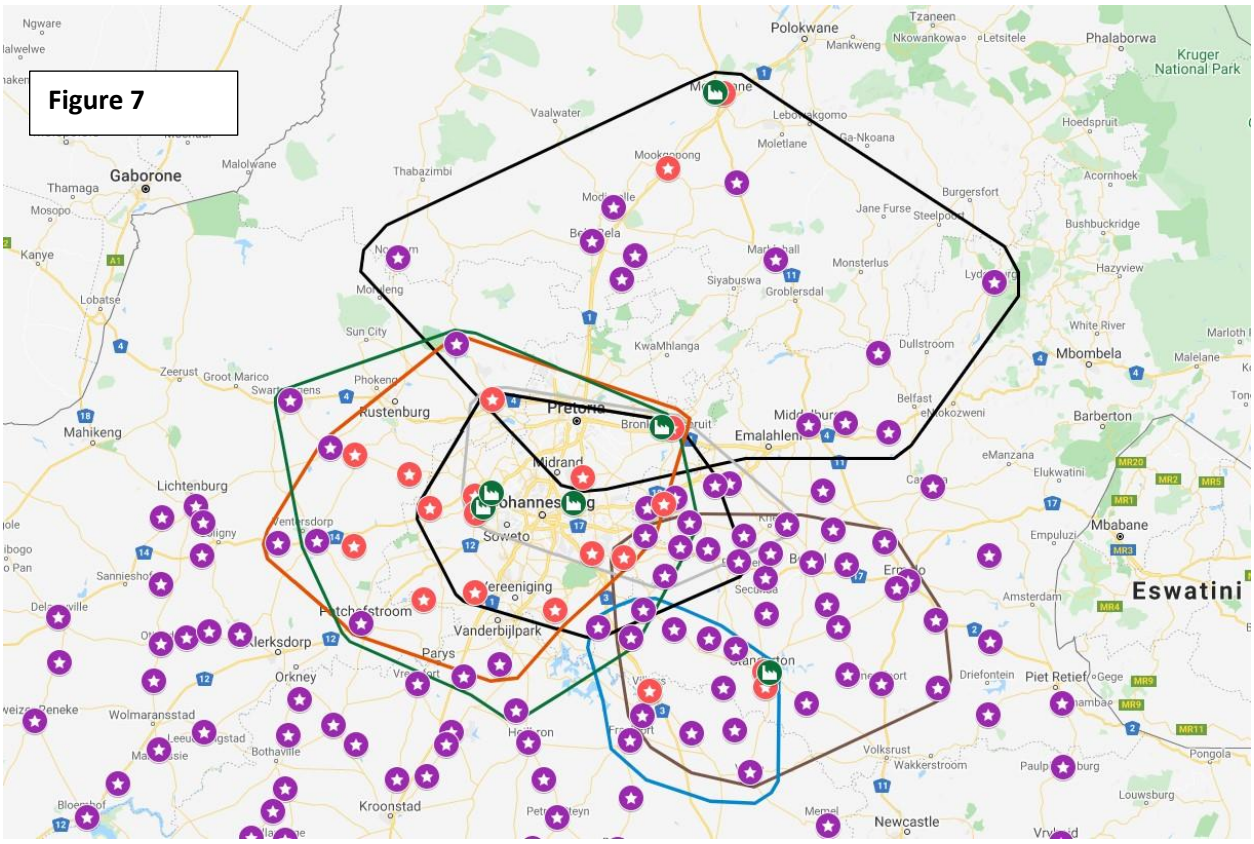
2.3 Price indifference and time

Although all the black star silos will be utilized in a marketing season's time, some would be utilized at the beginning of the season, while others would only be utilized at the end of the season. Deliveries from silos closest to processing plants will be accepted immediately, while the least cost-effective silos will only be accepted at the end of the season, with the other silos somewhere in between. This may still result in some redeliveries of black star silos however this is expected to be over a shorter time period and much more limited than before.

Location differentials for all silos, with both purple and black stars will therefore be calculated to become price indifferent within a month. The location differentials of silos closest to the processing points will be zero and the least cost-effective silos will have the largest location differential. All other silos will have location differentials smaller than the largest location differential, but larger than zero.

2.4 Silos with zero location differentials

The silos which will be price indifferent within the course of one month, therefore with a zero location differential, can be seen in **Figure 7**. The model has been programmed to assume demand requirements for one month and not a full year, hence this time period is used to identify which silos qualify for a zero location differential.



The model assumes that price indifference must be reached within one month and so the 19 sites represented by orange stars in Figure 7 will not need any discount and silo receipts from these locations will be traded at par. It is envisaged these silos will provide sufficient arbitrage opportunities for sellers who wish to deliver soybeans without any discount.

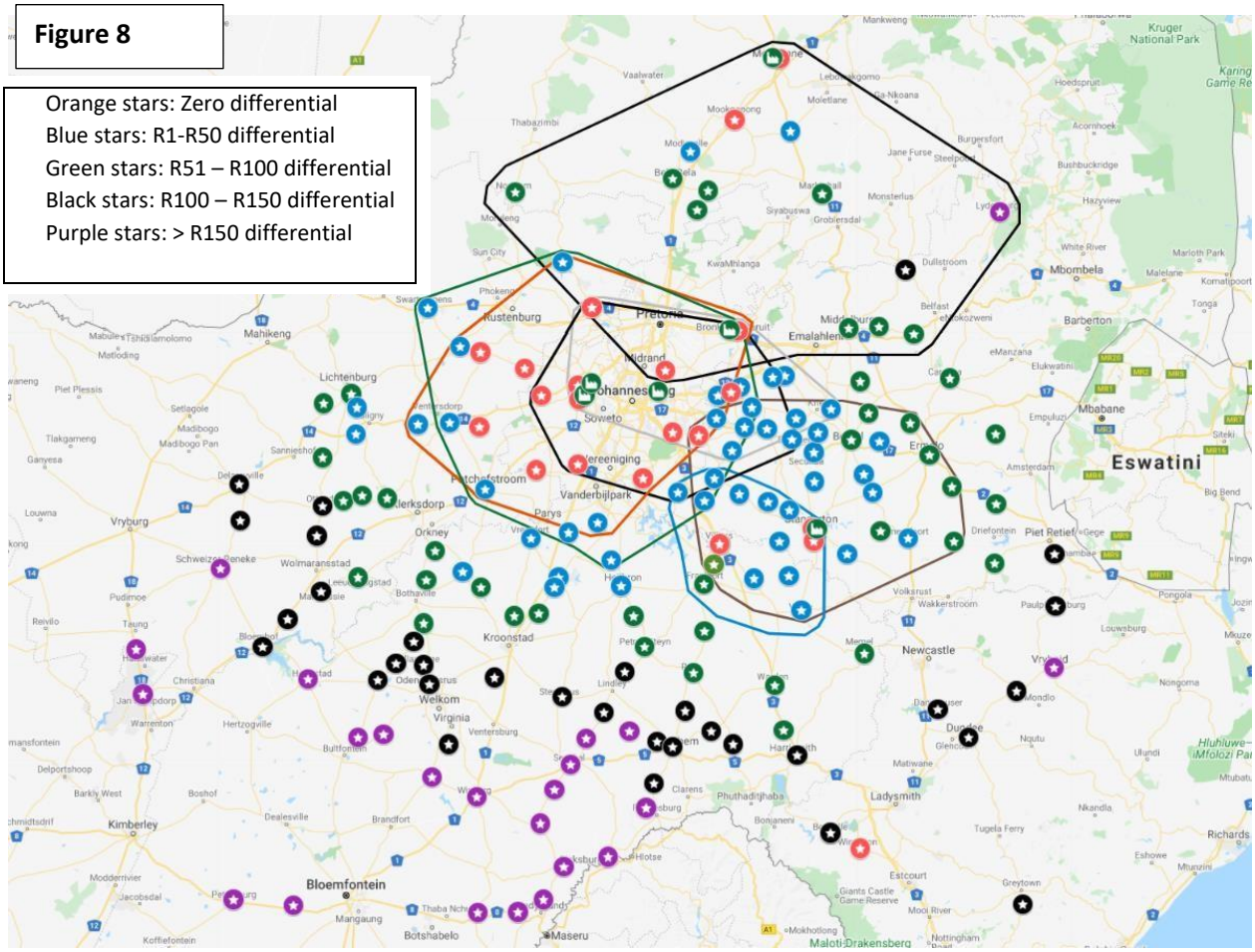
Since the introduction of select sites with a zero differential will come into existence with this methodology, the JSE envisages market participants through willing buyer willing seller principle will price the location differential component into the overall futures price that will be traded. In other words, if the actual cost for the buyer to move product from the sites marked with orange stars is say R50 per ton, going forward we expect the overall futures price would trade R50 lower as a once off when this new methodology is implemented.

2.5 Location differentials for indifferent ex-silo prices

Figure 8 is a graphic summary of soybean location differentials as calculated by the supply and demand model.

Figure 8

Orange stars: Zero differential
Blue stars: R1-R50 differential
Green stars: R51 – R100 differential
Black stars: R100 – R150 differential
Purple stars: > R150 differential



The silos with the largest location differential are Thaba Nchu and Tweespruit near Lesotho. It is clear from Figure 8 that the size of location differentials increases as distances from processing plants get larger. The new proposed model therefore in a number of ways still relies on similar thinking to the current location differential, however instead of only having Randfontein as a reference point, the various processing points are all considered and product that is furthest away from this will still see the largest location differential.

2.6 The reality of changing supply- and demand

The dynamic nature of the model also incorporates trends within the underlying fundamentals of the market. By using a three-year moving average, stability is provided in the framework to determine the differentials, but it also allows the market to adjust to structural changes should these occur.

As an example, the methodology will reflect this by assigning larger location differentials to affected silos as production trends increase, or smaller location differentials with a decrease in the production trend.

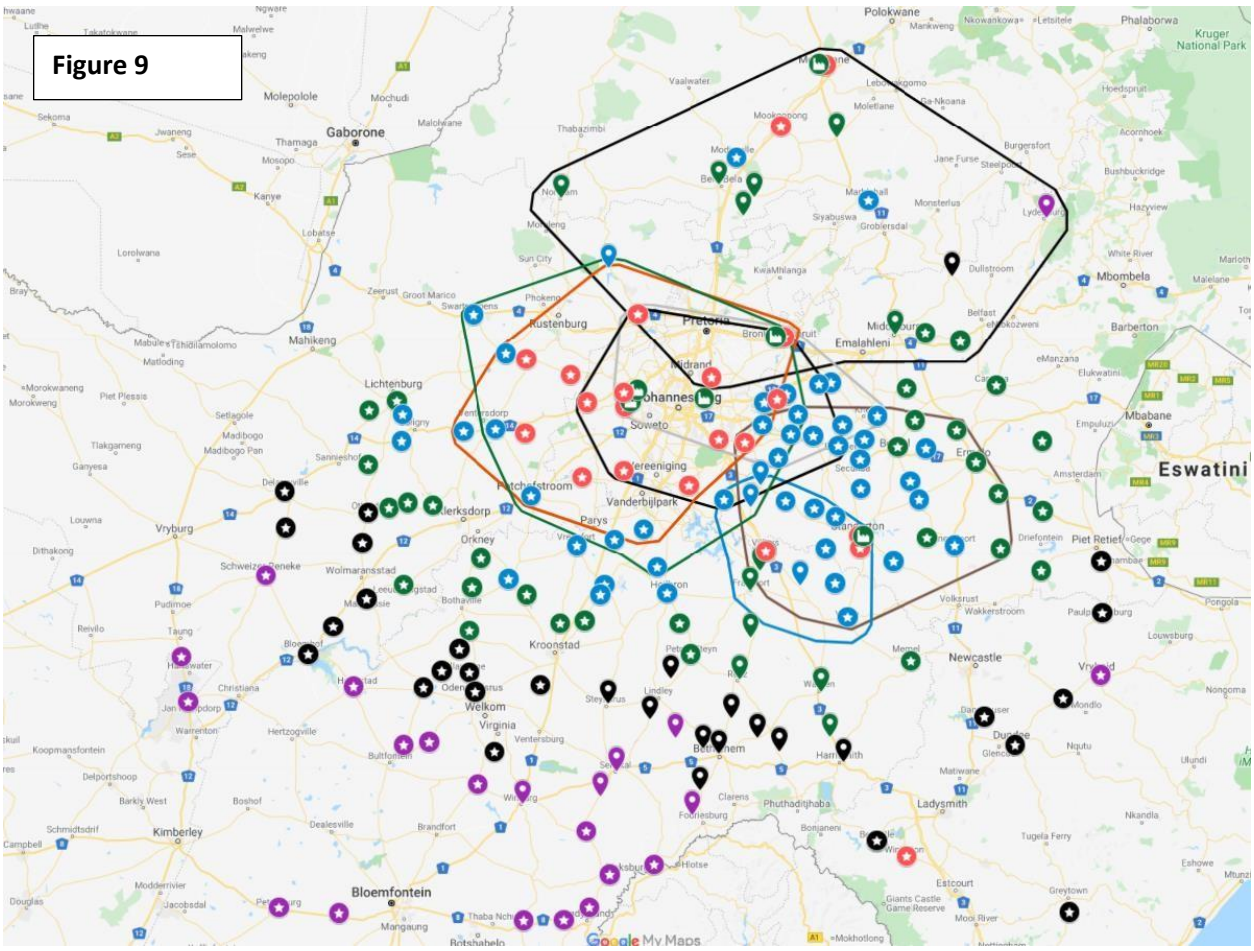
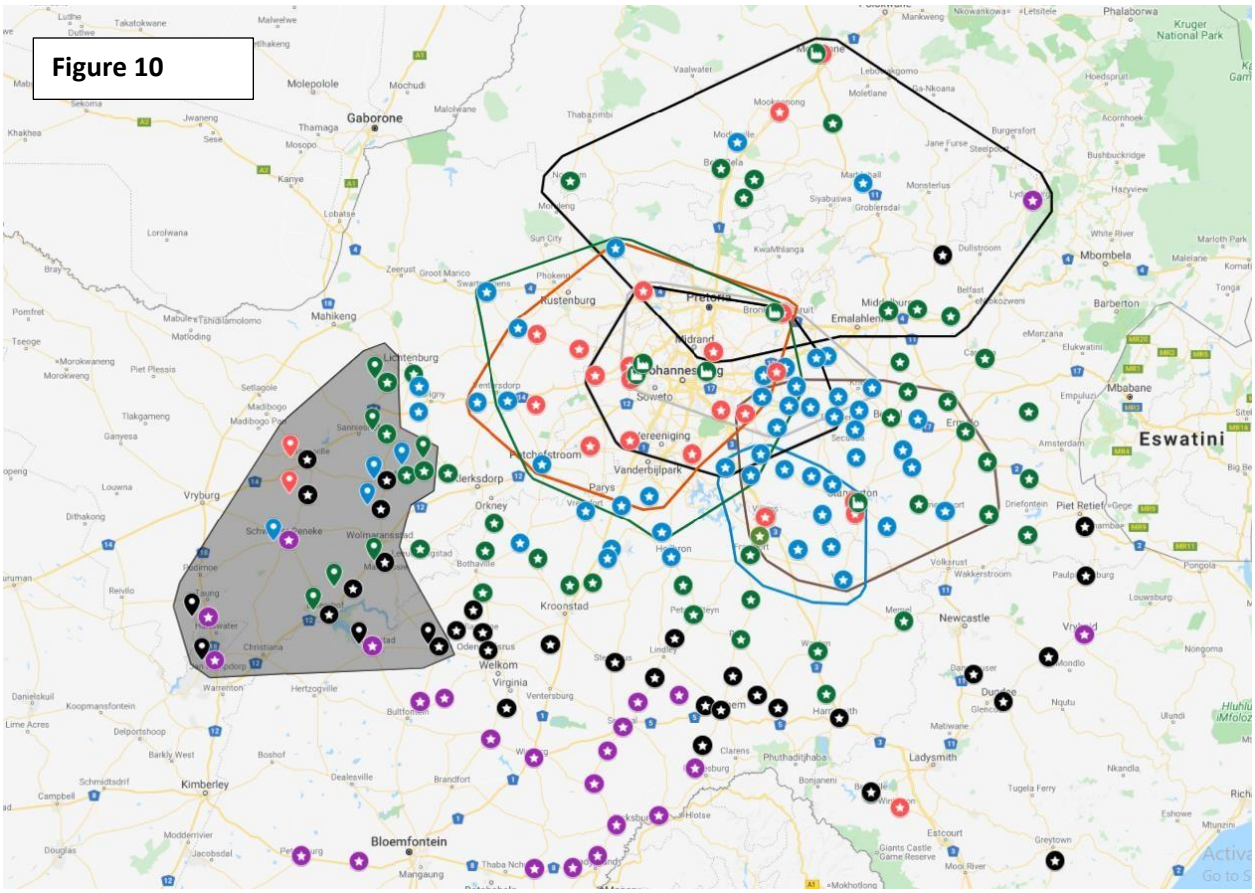


Figure 9 shows the effect of a larger crop trend. The inverted teardrops show 36 silos that would have had increased location differentials.

This location differential calculation system can also accommodate changes on the soybean demand side. Figure 10 illustrates how location differentials would have changed if, for example, if a 48 000t soybean crushing facility came into production at Delareyville.



The grey polygon in **Figure 10** shows the location of affected silos of a theoretical soybean processing plant coming into action in Delareyville. The Delareyville and Migdol silo's location differentials would have been reduced from R142 to zero. Wesselsbron would have had the smallest reduction, from R140 to R129, with the other silos in the polygon somewhere in between. Should production in the polygon area increase and therefore a larger supply, location differentials would be impacted and would also get larger.

In conclusion

The proposed methodology aims to calculate the differentials as close as possible to the cash market by using multiple processing points as a reference. Given the South African market structure with a large number of delivery points and the financial structure where more than 80% of the crop is produced under production finance the proposed methodology provides the opportunity to have a marketing year starting point close to the realities of the physical market. This is still very much theoretical and market sentiment and seasonality will continue to utilize premiums to facilitate preferences and trade.

The JSE is pleased with the approach this new model takes in trying to address a number of the age-old arguments raised by various market participants. This new methodology will therefore move away from the reliance of a single reference point for the derivatives contract but rather consider all points of processing. It will also introduce the concept of a zero differential for selected sites and from there continue to apply a location differential to JSE delivery points depending on their distance to the

processing points. It is envisaged the model will continue to rely on inputs specific to a rand per kilometre (RPK) rate or cents per kilometre (CPK) rate that the JSE will continue to collect and publish.

That said the reference to Randfontein as a single reference point will no longer apply to the soybean derivatives contract and also the distances will no longer be published as the model will rely on the linear programming model to determine to most effective location differentials.