Farm Level Cost-benefit Analysis: The Evaluation of Economics of Conservation Agriculture in Bergville Town in Kwa-zulu Natal Province of South Africa

Sanelise Tafa, Olusegun J. Ijila, Ajuruchukwu Obi, Godwin I. Nebo

ABSTRACT
Background: Practicing the unsustainable system of farming contributes in no small way to soil deterioration which in turn affects agricultural productivity. Even though one of the important requirements for embracing any agrarian practice is the financial viability of the process, it is believed that the differences in the benefits obtained from both conventional farming and conservation agriculture are not well articulated. While general inference can be made, it is also important to make a thorough evaluation of the benefits that can be derived from conservation agriculture and conventional agriculture.

Methods: The study was conducted in Okhahlamba Local Municipality, which is situated in-between Lesotho, Free State Province, Alfred Duma and the Inkosi Langalibalele Local Municipality. Secondary data were retrieved from the Mahlathini Organics dataset collected from three different seasons, such as 2012/2013 to 2014/2015 and 2016/2017 seasons. The farmers under study practiced conservation agriculture (0.8ha) and conventional agriculture (0.8ha).

Result: Using Gross Margin in addition to indicators like Benefit-Cost Ratio, Internal Rate of Returns and Net Present Value, this research identified that the advantages of using the conservation system of farming are enormous when matched with conventional agriculture. Consequently, this research suggests the advancement and encouragement of conservation agriculture as it provides more incentives in the long run.

Key words: Conventional agriculture, Conservation agriculture, Gross margin, Internal rate of return, Net present value.

INTRODUCTION
The livelihood of rural households in Bergville town of the Okhahlamba Local Municipality located in the Kwa-Zulu Natal Province of South Africa is directly related to their natural resource base (Barney and Mthembu, 2012). Specifically, the “land”, which receives high rainfall with large areas covered with medium to high potential soils, making it a substantial part of the Province suitable for cultivation, for both commercial and subsistence purpose (Stronkhorst et al., 2010). However, steep slopes and high degradable soil due to high rainfall, combined with conventional agriculture, pose a serious threat to this important resource and consequently to the entire agricultural community in the region (Stronkhorst et al., 2010).

In response to that, in the year 2000, the Agricultural Research Council (ARC) introduced conservation agriculture (CA) practices in the area in order to minimize the effects of soil degradation while improving the soil structure, thus improving farmers yield. When the CA project was introduced, the response to the adoption was positive to the point that the number of participants in the program increased from the 20 trained lead farmers to 85 farmers. However, when the ARC-project came to an end in 2005, the farmers that adopted the CA did not continue. There was the anecdotal evidence that farmers did so because benefits were not sustained.

In 2013, the program was revived by the Mahlathini Organics, the Non-Governmental Organization (NGO) based in Pietermaritzburg in KZN, under the Grain-South Africa Conservation Agriculture-Foundation Innovation Program (Grain-SA CA-FIP) and Save Act Trust (Kruger, 2014). According to Kruger (2014), the Mahlathini Organics re-introduced the CA practices in the area as a pilot study to the organized smallholder farmer groups from six different villages. The NGO took note of the corridor talk and designed the new intervention to control for the things that may have caused the previous project to fail. However, there is a lot of optimism now and it seems that they have addressed the concerns and this is likely to influence public policy in respect to support for CA. So, this study seeks to apply cost-benefit theory to ascertain that this enthusiasm and optimism will be sustained.

Conceptual framework
Costs mentioned in Fig 1 are mainly the values of inputs...
Farm Level Cost-benefit Analysis: The Evaluation of Economics of Conservation Agriculture in Bergville Town in Kwa-zulu-

that are normally used during the maize production. Input costs that each farmer should take into cognizance during the decision making involve labour, fertilizer, pesticide and seeds costs. In broad terms, farmers will opt for a certain innovation if and only if, one of the conditions is met, i.e. yields increase and decrease in production costs (Uri, 2000). However, costs can either be high or low. Moreover, the mentioned costs can either be in monetary value or non-monetary. The monetary costs of using CA include the direct financial inputs. On the other hand, non-monetary cost includes the opportunity costs of resource used in CA model. For example, one of the principles of CA is mulching. So, the crop residue which was supposed to be feeding livestock has no monetary value, however it is used as one of the production inputs. In summary, the cost mentioned in CA technology covers the financial inputs and the opportunity costs of resources (Pannell et al., 2014).

According to Uri (2000), the history in the literature tells us that farmers used to reflect productivity when considering the alternative production technologies. However, nowadays, profitability and the goals of the farmer have become the sole factors of consideration. This is because that yield increases do not guarantee the increase in profit; hence the central issue is to find whether the value of the yield increase justifies the costs. The goals of farmers encapsulate the needs and the desires of the farmer. It is important to note that needs and desires of a farmer are very important, especially for the smallholder farmers. Hence, it is important not to limit the benefit and cost analysis in monetary value, rather considering the farmers’ goals of production. For that reason, market prices might not be attractive to some farmers than the marginal value of some products (Pannell et al., 2014).

MATERIALS AND METHODS

Study area

The study area is one of the five Local Municipalities within the Uthukela District Municipality, sited in the mountain region of KZN. To be more specific, Okhahlamba Local Municipality (OLM) is in-between Lesotho, Free State Province, Alfred Duma and the Inkosile Langalibalele Local Municipality and covers an area of about 3971 km². Around the OLM are commercial farmlands that are private and smallholder settlement with urban areas which are Winterton, Geluksberg, Bergville and Cathkin Park.

Data collection method

The research methodology for this study consisted of four main components:
1. Site visit to 6 different farmers’ groups from Bergville. These visits were conducted in the first week of March 2017, specifically the first 6 days.
2. At the time of site visit, GrainSA was hosting CA farmers’ day and that paved the way for the researcher to meet with the Mahlathini Organics members. Farmers from different villages practicing CA were present at the CA farmers’ day and about 5 farmers were interviewed.
3. The days following the CA farmers’ day, approximately 10 interviews and group meetings were held with CA farmers from Stulwana, Potshini, Qeleni and Ezidulwini. The objective of these interviews was to explore wide range of agricultural practices in Bergville.
4. The interviewed farmers were practicing conservation agriculture and conventional agriculture. Each plot had a size of 0.8 hectare.
5. Analysis of qualitative and quantitative secondary data retrieved from the Mahlathini Organics collected in the 2013 to 2017 seasons was used.

Gross margin

A gross margin (GM) is calculated by subtracting variable costs from financial output (revenue). Variable costs are the input costs that were recorded by Mahlathini Organics during the 2016/17 production season. The following formula was used in calculating gross margin:

![Fig 1: Conservation Agriculture cost benefit Conceptual framework adapted from Pannell et al. (2014).](image-url)
Gross margin = Total revenue - Total costs............................(1)
Where:
Total revenue = Price per unit × Quantity sold....................(2)
Total costs = Fixed cost + Variable cost............................(3)

It is important to note that the study used smallholder farmers as its subjects. Smallholder farmers in the study area, instead of using tractors, they used hand hoes and animal drawn planters. The costs of these equipment contribute to the fixed costs. Furthermore, these farmers were using communal land that was not fenced and practicing rain fed agriculture.

**Appraisal indicators**

Developmental projects, environmental programs and natural resources have been applying the CBA in order to find out the social economic information that can be useful in governmental decision making (Ogunlade, 2008). One of the following decision standards can be used:

- The Net Present Value (NPV)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

\[ NPV = \sum_{i=0}^{n} \frac{B_i}{(1+R)^i} - \sum_{i=0}^{n} \frac{C_i}{(1+R)^i} \] ........................(4)

Another yardstick that is commonly used to gauge the viable investment decision is the BCR. The formula for the BCR is shown below:

\[ BCR = \frac{\sum_{i=0}^{n} \frac{B_i}{(1+R)^i}}{\sum_{i=0}^{n} \frac{C_i}{(1+R)^i}} \] ........................(5)

Lastly, the investment decision also depends on an IRR. There are various methods of calculating IRR. The one that is used in this paper is an extrapolation method and the mathematical representation is as follows:

\[ IRR = R1% + \frac{NPV1 \times (R2 - R1)\%}{NPV1 - NPV2} \] ........................(6)

Where:
R1-lower discount rate (8% in the study).
R2-higher discount rate (19% in the study).
NPV1-Higher net present value that was derived from R1.
NPV2-Lower net present value derived from R2.

In interpreting the investment decision criteria, a proposed project can be reckoned feasible if the:
- NPV is positive
- BCR is greater than the digit of one
- IRR is greater than the applicable discount rate.

Although there are difficulties in measuring the cost and benefit, this research thesis will employ all the three decision rules. This is to present the solid decision making. The rationale behind this chapter is to bring the in-depth discussion of these elements.

**Discount rate**

The effects of discounting are important for any project that involves immediate expenditures while the benefits are not manifested until sometime in the future like in the case conservation agriculture. For the purpose of this dissertation, the discount rates were based on the Water Research Commission Report No. TT 305/07 (Mullins et al., 2012). In the report, it is argued that the discount rate that should be used for environmental projects in South Africa should be discounted at the official discount rate at 8%. The formula used for calculating internal rate of return (IRR) required the calculation of two net present value NPVs. One of these NPVs should positive, while another one should be negative. Through extrapolation, the one rate at which NPV is negative was 19%. These were discounted over a 10-year period.

**RESULTS AND DISCUSSION**

**Yield**

Each farmer in the study area was allowed to have two separate plots, trial plot and control plot. The trial plot was the plot in which CA was being experimented while the control plots were plots where farmers use their ‘normal’ farming practices in terms of tillage and fertility amendments (Kruger, 2016). Average yield results presented in Table 1 vary from one tillage system to the other. In 2012/2013, the average yield from the trial plot was 3.26 tonnes per hectare while in the control plots, it was 3.39 tonnes per hectare. Table 1 also reveals that the average yield per hectare in the trial plots increased from 3.26 tonnes per hectare in 2012/2013 to 4.12 tonnes per hectare in 2013/2014 and finally got to 4.45 tonnes per hectare in 2014/2015. On the other side, the average yield in the control plots was 3.39 tonnes per hectare in 2013, 5.40 tonnes per hectare in 2014 and 3.05 tonnes per hectare. In the 2016/2017 season, CA farmers the average yield of 3.94 tonnes per hectare while the conventional agriculture farmers had the yield of 3.36 tonnes per hectare.

From every indication, it can be deduced from the results that the trial plots showed a positive increase (except the decrease that was in 2016/2017 season), while in control plots the average yield levels were inconsistent. The inconsistency in average yield levels of control plots is attributed to poor land management practices that lead to soil degradation (Sihlobo, 2016). On the other side, the increase in average yield levels in trial plots over the control plots is attributed to many factors related to the introduction of CA in the farm such as increase in water retention and increased fertility level.

| Planting season | Conservation Agriculture (tonnes/ha) | Conventional Agriculture (tonnes/ha) |
|-----------------|-------------------------------------|-------------------------------------|
| 2012/2013       | 3.26                                | 3.39                                |
| 2013/2014       | 4.12                                | 5.40                                |
| 2014/2015       | 4.45                                | 3.05                                |
| 2016/2017       | 3.94                                | 3.36                                |

Source: (Kruger, 2016).
Variable costs

Variable costs include all the operating costs such as costs incurred on maize seeds, fertilizers, herbicides, pesticides, ploughing, labor and dicing (Table 2). The extent of each variable cost is quantified in relation to the total variable costs in each tillage system. The seed cost in trial plots takes about 18.25% of the total variable costs while in control plots, it accounts for 4.30% of total variable costs. These results are in consistence with Uri (2000) research results which concluded that it has been recommended that seed rate increases with the adoption of CA when seeds are planted in a narrow rows or drilled.

Many studies have hypothesised that fertilizer use will increase with the adoption of CA compared to conventional agriculture (Lai et al., 2012; Ngwira et al., 2014). However, the present study reveals that fertilizer use makes about 16.15% in the trial plots while in control plots, the fertilizer use make about 19.22% of the maize variable costs (Table 2). Low fertilizer use in CA plots was due to the belief that the plant remains kept the soil fertile.

Herbicide use increases the variable costs by 2.30% in the trial plots. Herbicide were not used in the control plot because soil preparation and turning is believed to reduce the level of weeds in the farm. Following this variable cost, pesticide use took about 0.61% of variable costs in the trial costs. These results are confirming Du Toit (2007) research results which reported that the CA adoption is accompanied by the use of pesticides as opposed to the conventional agriculture.

Ploughing and dicing are soil preparation activities mostly followed by conventional farmers. These two activities cannot be excluded when comparing the costs of CA against conventional agriculture. It must be noted that ploughing and dicing in the smallholder setting usually involves manual hoeing using hand hoes or animal-drawn plough. However, the smallholder farmers in the study area mostly hire tractors or animal drawn for ploughing and dicing activities. It is for this reason that the cost of ploughing and dicing to be 16.54% and 8.27% in the control plots, while there is no cost incurred for ploughing and dicing for trial plots because CA involves the no-tillage or minimum tillage system (Table 2).

Labour costs are very important in every industry. In agriculture, the number of labour hours devoted to each tillage operations are different between CA and conventional farming. In the trial plot, labour costs make about 62.69% of the total cost while in the control plots, labour cost makes about 51.67% of the total variable costs. These results contradicts the notion which says that CA saves considerable amount of labour (Friedrich et al., 2012). One of the reasons for this increase in labour requirement is the small proportion of herbicide and pesticide costs in the variable costs.

Fixed costs

Fixed costs are costs that remain constant even if the size of production can change. Table 2 presents fixed costs that were incurred when starting the two projects, conservation agriculture and conventional agriculture. Fixed costs that were under conservation agriculture include animal drawn planter, handhole, hand-planter, hand-gloves, tape measure and knapsack sprayer. All the mentioned fixed costs were also found in conventional tillage, except the knapsack

| Table 2: Evaluation of trial and control plot cost and benefits. |
|---------------------|---------------------|---------------------|---------------------|
| Variable cost       | Trial Plots (Rands/0.8ha) | Control plots (Rands/0.8ha) |
|                     | Quantity (kg) | Price/Unit | Cost (Rand) | % of Cost | Quantity(kg) | Price/Unit | Cost | % of Cost |
| Seed (Maize)        | 3.5            | 104.00     | 364.00      | 18.25      | 1 (25kg bag) | 104.00     | 104.00 | 4.30      |
| Fertilizer          | 35             | 9.20       | 322.00      | 16.15      | 93.00       | 5.00       | 465.00 | 19.22     |
| Herbicide           | 0.42           | 109.00     | 45.78       | 2.30       |             | 74.00      |       |
| Pesticide           | 0.014          | 875.00     | 12.25       | 0.61       |             |           |
| Ploughing           | 0.80 ha        | 500.00     | 400.00      | 16.54      |             |           |
| Disc                | 0.80           | 250.00     | 200.00      | 8.27       |             |           |
| Labor               | 5.00           | 250.00     | 1250.00     | 62.69      | 5.00        | 250.00     | 1250.00 | 51.67     |
| (A) Total variable costs | 1,994.03 | 100% | Total variable costs | 2,419.00 | 100% |
| Fixed Costs         | Quantity (numerical value) | Price/unit | Cost (Rand) | % of Cost | Quantity (numerical value) | Price/unit | Cost (Rand) |
| Animal drawn planter | 1              | 2,500.00   | 2,500.00   | 1         | 2,500.00   | 2,500.00   |
| Hand hoe            | 3              | 74.00      | 222.00     | 3         | 74.00      | 222.00     |
| Hand planter        | 1              | 1052.00    | 1052.00    | 10        | 32.00      | 320.00     |
| Gloves              | 10             | 32.00      | 320.00     | 10        | 32.00      | 320.00     |
| Tape measure        | 1              | 54.00      | 54.00      | 1         | 54.00      | 54.00      |
| Knapsack sprayer    | 2              | 400.00     | 800.00     | 2         | 400.00     | 800.00     |
| (B) Total fixed costs |               | 4,948.00   | 3,096.00   |           | 6,942.03   | 5515.00    |
| (C) Total costs (A+B)|               | 6,942.03   | 8,400.00   |           |            |            |
| Income from sales   | Quantity (tonnes) | Price/unit | Product value |         | Quantity (tonnes) | Price/unit | Product value |
| (D) Revenue         | 3.94           | 2,500.00   | 9,850.00   | 3.36      | 2,500.00   | 8,400.00   |
| Gross Margin (D-C)  |                | 2,907.97   | 2,885.00   |           | 2,885.00   |            |

Source: Author’s computation (2017).
In this regards you may please reply of the reviewer comments mail.

Farm Level Cost-benefit Analysis: The Evaluation of Economics of Conservation Agriculture in Bergville Town in Kwa-

Table 3: The Cost Benefit Analysis results.

| Year | Trial plots @ 0.8 ha | Control plot @ 0.8 ha |
|------|---------------------|-----------------------|
|      | Cash-outflows | Cash-inflows | Net-cashflows | Discount factor @ 8% | NPV | Discounted cash-outflows | Discounted cash-inflows | Net-cashflows | Discount factor @ 8% | NPV | Discounted cash-outflows | Discounted cash-inflows |
| 0    | 6942.03 | 2907.97 | -403.06 | 1 | 6942 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 1    | 1994.03 | 2907.97 | 913.94 | 0.857 | 784 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 2    | 1994.03 | 2907.97 | 913.94 | 0.794 | 726 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 3    | 1994.03 | 2907.97 | 913.94 | 0.735 | 672 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 4    | 1994.03 | 2907.97 | 913.94 | 0.681 | 622 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 5    | 1994.03 | 2907.97 | 913.94 | 0.630 | 576 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 6    | 1994.03 | 2907.97 | 913.94 | 0.583 | 533 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 7    | 1994.03 | 2907.97 | 913.94 | 0.540 | 494 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 8    | 1994.03 | 2907.97 | 913.94 | 0.500 | 451 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 9    | 1994.03 | 2907.97 | 913.94 | 0.463 | 423 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |
| 10   | 1994.03 | 2907.97 | 913.94 | 0.463 | 423 | 2908 | 5515 | 2885 | -2630 | 1 | -2630 | 5515 | 2885 | -2630 |

\[
\sum NPV = 2099 \\
\sum NPV = 498
\]

BCR = 1.10

To calculate IRR for trial plots: R1% = 8%; R2% = 19% NPV1 = 2099; and NPV2 = -70

IRR = R1\% + \frac{NPV1 \times (R2 - R1)\%}{NPV1 - NPV2} = 8\% + \frac{2099 \times (19 - 8)\%}{2099 - (-70)} = 18.64

To calculate IRR for control plots: R1\% = 8%; R2\% = 19% NPV1 = 496.90; and NPV2 = -608.0

IRR = R1\% + \frac{NPV1 \times (R2 - R1)\%}{NPV1 - NPV2} = 8\% + \frac{496.90 \times (19 - 8)\%}{496.90 - (-608)} = 12.95

Source: Author's computation.
sprayer. This knapsack sprayer was used by some farmers to remove weed before planting, in an effort to clear the soil.

**Gross margin**

Although gross margin is highly dependent on the variable costs incurred during the production season, it cannot be isolated when farm managers need to adopt the tillage system. The reason being that yield increase alone cannot be the only justification for adoption decision. Trial plots made about R2909.97 of GM while control plots made about R2885.00 (Table 2). The major cause of the difference in GM is the differences in variable costs.

**Comparison of CA and Conventional farming using Appraisal indicator**

The appraisal indicators used in this research are Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Rate (IRR) (Table 3). The appraisal indicators were used to quantify the net financial gains for investing in Trial and Control plots, discounted at 8% and 19%.

NPV is presented in Table 3 with a projection of 10 years period at 8% and 19% discount for both tillage systems. At 8% discount rate, the trial plots (i.e., CA plots) resulted in NPV of R2099.00 while the NPV for control plots (i.e., Conventional agriculture plots) is R498.00. At 8% discount rate, the trial plots resulted in B/C ratio of 1.10 while the control plots yielded a ratio of 1.01. This therefore means that at 8% discount rate, NPV and BCR show that both projects are viable. However, it is more viable to produce maize using CA than using conventional tillage system. The results therefore confirm the report presented by ARC (2014) asserting that CA is more viable than conventional farming.

In order to calculate IRR, extrapolation method was used. This method helped in finding the rate at which NPV will be negative for both tillage systems. It was therefore found out that NPV will be negative at 19%. NPV that was obtained through using 19% interest rate was used as the lower NPV, while NPV that was obtained at 8% was used as a higher NPV. IRR was obtained through manual calculation, using formular no. 6. The results showed that the trial plots would be profitable at 18.64% while control plots would be profitable at 12.95%.

**CONCLUSION**

Conservation agriculture is an arrangement that consolidates the core guiding principles (mulching, zero-tillage and crop rotation) and operates concurrently to generate physical-biological and socio-economic benefits to agribusiness. However, the benefits of conservative agriculture come with its challenges. For instance, the yield and other benefits in conservation agriculture take a very long time to materialize and the smallholder farmers find it difficult to sacrifices their revenue in the short-term, even when there's a likelihood for greater advantages in the long-run. When considering the small-scale farmers, starting conservation agriculture has a huge financial implication compared to conventional agriculture. Nevertheless, the gross margin (GM) in conservation agriculture is high in comparison with conventional farming. There are a lot of factors influencing the amount of Gross Margin in all the tillage methods practiced, but then, the one with the lowest operating expense is conservation agriculture.

Projecting for 10 years and discounting at 8% and 19% discount rates, the indicators established that both CA and conventional tillage are viable. However, it was revealed that there are more incentives for adoption of CA as compared to CT. One super advantage of CA over conventional agriculture is low operating costs, even though there are high investment charges compared to CT.

**REFERENCES**

Agricultural Research Council (ARC). (2014). Assessing the impact of conservation agriculture practices on wheat production in the Western Cape. Economic and Biometrical Service, (March), 1-40.

Barney, M. and Mthenbu, J. (2012). Rural tourism development: a viable formula for poverty alleviation in Bergville. 4(1): 63-74.

Du Toit, G. (2007). The Bureau for Food and Agricultural Policy (BFAP). Policy Report, 4.

Friedrich, T., Derpsch, R. and Kassam, A. (2012). Overview of the global spread of conservation agriculture. Field Actions Science Reports. 6(6): 1-7.

Kruger, E. (2014). Attachment 2: Annual Report Ca Farmer Innovation Programme (CA-FIP) for. Mahlathini Organic, (October 2013): 2003-2015.

Kruger, E. (2016). Annual Report Ca Farmer Innovation Programme (CA-FIP) for. Mahlathini Organics.

Lai, C., Chan, C., Halbrendt, J., Shariq, L., Roul, P., Idol, T., et al. (2012). Comparative economic and gender, labor analysis of conservation agriculture practices in tribal villages in India. International Food and Agribusiness Management Review. 15(1): 73-86.

Multins, W., Cloete, R. and Matthee, M. (2012). Ncwabeni of-channels STORAGE DAM/ Economic Feasibility. P WMA 11/T52/00/3211/3.

Ngwira, A., Johansen, F.H., Aune, J.B., Mekuria, M. and Thierfelder, C. (2014). Adoption and extent of conservation agriculture practices among smallholder farmers in Malawi. Journal of Soil and Water Conservation. 69(2): 107-119.

Ogunlade, A.A. (2008). Comparative cost-benefit analysis of renewable energy resources for rural community development in Nigeria (Doctoral dissertation, North-West University).

Pannell, D.J., Llewellyn, R.S. and Corbeels, M. (2014). The farm-level economics of conservation agriculture for resource-poor farmers. Agriculture, Ecosystems and Environment. 187: 52-64.

Sihlobo, W. (2016). An evaluation of competitiveness of South African maize exports (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Stronkhorst, L., Mapumulo, C., Trytsman, G., Breytenbach, F., Lötter, L., Mpanza, T. (2010). Report: Local Level Land Degradation Assessment on commercial farms in Winterton, Kwa-Zulu Natal Province. Agricultural Research Council-Institute for Soil, Climate and Water.

Uri, N.D. (2000). An evaluation of the economic benefits and costs of conservation tillage, Environmental Geology. 39(3-4): 238-248.