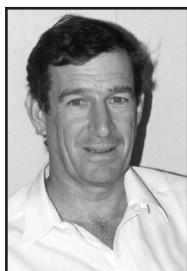


The Southern Cape Crop Rotation Research Project:

Progress 2002 -2005



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Introduction

The Western Cape Department of Agriculture initiated a crop rotation research program in the Southern Cape in 2002. Funding for the project is provided by the Western Cape Department of Agriculture, the Winter Cereal Trust and the Protein Research Foundation. GSA (Western Cape Region) strongly supports the research.

The main objective of the southern Cape long-term crop rotation trial is to investigate the economic sustainability short- and long-rotation, crop and crop/pasture production systems in the Southern Cape. Conservation farming, no-till production practices are followed in all the cropping rotations being tested.

Three research sites were established, two with relatively high grain production potential (at Riviersonderend [Tygerhoek] and Riversdalee – growing season rainfall 200mm to 280mm) and another in a region with low grain production potential south of Swellendam (growing season rainfall 130mm to 180mm) -. The research sites in the Riversdalee and Swellendam districts are on private farms and the farmer co-workers are responsible for crop management through the season.

Two important principles are followed in the management of the crops and pastures at the research sites:

- Individual research plots are large enough to allow for the use of normal farm implements such as planters, spray booms, fertilizer distributors and combine harvesters, and
- The management of each crop is based on the best information available to producers. A team of technical advisors that includes producers has been formed for each of the research sites to ensure that each crop and pasture is managed according to the best technical information available to producers.

The purpose of this article is to provide a summary of crop production data from each of the experimental sites for the period 2002 to 2005.

Soil preparation at each site

Because a no-till production system was to be followed the first task was to correct any physical and nutrient deficiencies that were identified in the soil. With the help of Technifarm and Nitrophoska the experimental areas were 'grid sampled' and soils were analysed for macro and trace elements. Lime and fertilizer were differentially applied as required to ensure that the nutrient status of the soils of each camp in each of the experimental areas was above minimum levels for optimum production of the crops we intended planting.

Soil depth at the Riversdalee and, to an extent, the Tygerhoek sites are relatively deep (> 250mm) with a high stone fraction. Soils at the Swellendam site are shallow i.e. up to 300mm deep but mainly in the range 150 to 200mm with consolidated rock (shales) below a top soil that also has a high stone fraction.

Experimental treatments

Long-rotation crop sequences i.e 5 years of cash-cropping following five years of lucerne pasture, are being investigated at Riversdalee and Swellendam. The objective was to determine which of five different crop sequences provided the most economically viable options for crop production after lucerne when following a no-till production system. At Swellendam the SSK soil conservation committee also wanted to know what would happen in terms of grain production if the soils were tilled/scarified to 10cm before planting (a practice followed by many producers) when compared to no-till planting. The crop sequences that are being

tested at each of the Riversdalee and Swellendam sites are shown in Table 1.

Table 1: Examples of crop sequences being tested (following 5 years lucerne) at the Riversdalee and Swellendam research sites

Crop sequence	2002	2003	2004	2005	2006 (all under-sown with lucerne)
A	Wheat	Wheat	Oats	Wheat	Wheat
B	Wheat	Wheat	Canola	Wheat	Triticale or Barley
C	Wheat	Lupin	Wheat	Canola	Wheat
D	Wheat	Barley	Canola	Wheat	Wheat or Triticale or Barley
E	Wheat	Canola	Wheat	Lupin	Triticale
F	Wheat	Oats	Wheat	Canola	Wheat
(SSK - tilled)	Wheat	Barley	Canola	Wheat	Wheat

There are three plots for each crop sequence. So at Swellendam, for example, we had 3 plots (each 0.8ha in size) that were planted to lupins for crop sequence 3 in 2003.

Short-rotation crop and crop pasture sequences are being tested at Tygerhoek. Continuous cropping e.g. wheat/barley/canola/wheat /barley/lupin, is compared to crop/annual legume pasture (a mixture of medic and clovers) systems. The crop/pasture systems include: 2 years pasture followed by 1 year crop; 1 year pasture followed by 1 year crop; and 2 years pasture followed by 2 years crop.

Summary of crop yields - 2002 to 2005

2002 (the 1st season)

Canola production

Canola (*Varola 50*) was planted only at the Tygerhoek site. Plant density was low (10 to 30 plants per ha) in most plots but excellent yields were obtained in all (1450 to 2000 kg/ha) but one (800 kg/ha) of the 0.25ha plots. Lodging made harvesting difficult causing a high percentage of seed to be lost during harvesting. It was estimated, that for all plots, yield losses due to wind and bird damage could have been as high as 30%. Oil content ranged from 38.6 to 42.9%. Interestingly these oil content are 3 to 4 percentage points higher than those typically recorded for ATR Hyden (a TT canola cultivar).

Lupin production

Lupins (Wongar) were planted only at the Tygerhoek site. Yields ranged from 990 to 1320 kg/ha.

Wheat production

Wheat (SST 57) was planted at all three sites. It was the only crop planted at both of the long-rotation trial sites (Table 1). The average wheat yields were 3100 kg/ha, 3050 kg/ha and 1790 kg/ha at the Tygerhoek, Riversdalee and Swellendam sites respectively. The lower production recorded at the Swellendam site was expected due to the extremely dry climate experienced in the area. This level of production was, however, higher than the average production recorded on farms in the district.

Barley production

Barley (*Clipper*) was planted only at Tygerhoek. The average yield from 10 plots was 3570 kg/ha with a yield range of 3200 kg/ha to 4100 kg/ha.

Oats production

Oats (*Kompasberg*) was planted only at Tygerhoek. Oats was included in the rotation systems as a dual-purpose crop for grain production and to have the option of producing hay in the event of grass weed problems. Grass weeds were indeed a severe problem on the research site. All oats plots were therefore harvested for hay. Dry matter yields of 4800 kg/ha to 5700 kg/ha were recorded.

2003

Canola production

Canola (*Varola 50*) was planted at the Riversdale site. ATR Hyden was planted at the Tygerhoek site so that Simazine could be used to control the severe grass weed problem that exists at the Tygerhoek site. Average plant densities were lower than expected (based on seeding rate, germination and survival potential) at 34 and 48 plants m⁻² for the Riversdale and Tygerhoek sites respectively. Yields ranged from 1700kg to 1800kg for the Riversdale site, and from 1500kg to 2300kg (average 1968kg) at the Tygerhoek site. Oil contents of the seed ranged from 29.9 to 35.3 at the Tygerhoek site, and from 35.4 to 35.8 at the Riversdale site. Low oil yields are of concern but are consistent with oil yield data that have been recorded for these cultivars elsewhere in the southern Cape and in Australia.

Lupin production

Lupins (*Tanjil*) were planted at the Riversdale, Swellendam and Tygerhoek sites. Simazine again provided good weed control at all sites (due mainly to the favourable rainfall and soil moisture conditions that prevailed during planting and seedling establishment). Average plant densities (plants m⁻²) were within the expected ranges viz Riversdale (40 to 44), Swellendam (47 to 66) and Tygerhoek (38 to 48). This was due to several factors including, good soil moisture at and subsequent to planting, a high seeding rate (85 to 110kg seed/ha) and good quality seed (thousand seed weight > 150g). Lupin yields were excellent at all three sites viz. Riversdale (2401 to 2509 kg/ha⁻¹), Swellendam (1407 to 1704 kg/ha⁻¹) and Tygerhoek (2584 to 3057 kg/ha⁻¹).

Wheat production

Wheat (SST 57) was planted at all three sites. Wheat yields were severely depressed at the Riversdale site by an abnormally cold spell that influenced pollination and early seed development during August. Wheat yields for Riversdale ranged from 1117 to 1696kg/ha⁻¹ (average 1380kg/ha⁻¹). At Swellendam high plant densities (>200 plants m⁻²) limited wheat production due to competition among wheat plants (planted in rows) for limited soil moisture during the period from late May to early July. Yields for Swellendam ranged from 1157 to 1361kg/ha⁻¹ (average 1238kg/ha⁻¹).

The extremely favourable rainfall conditions experienced at Tygerhoek resulted in average wheat yields across all plots of 4684kg/ha⁻¹ for wheat after legume pasture, 4399kg/ha⁻¹ for wheat after lupin, 4432kg/ha⁻¹ for wheat after canola, 4080kg/ha⁻¹ for wheat after oats, and 3639kg/ha⁻¹ for wheat after wheat. Plot location with respect to soils and aspect played a significant role in determining wheat yield with yields on the westerly aspects and on soils with a high stone fraction producing less than on plots with an easterly aspect. Wheat yields following legume pastures on plots with an easterly aspect ranged from 4658 to 5779kg/ha⁻¹ (average 5370kg/ha⁻¹).

Barley production

Barley (*Clipper*) was planted at all three sites. Yields ranged from 2838 to 2932 kg/ha⁻¹ at Riversdale, 820 to 1795 kg/ha⁻¹ at Swellendam, and 3665 to 5384 kg/ha⁻¹ at Tygerhoek, barley after pasture produced, on average, 450 kg/ha⁻¹ more grain than barley after wheat.

Oats production

Oats (*SSH 421*) was planted for hay at Tygerhoek while *SSH 405* was planted for grain at Swellendam. The *SSH 421* produced excellent dry matter yields (over 9000 kg/ha⁻¹) at the Tygerhoek site. Taking the oats off as hay before grass weeds (mainly ryegrass) could produce mature seeds also provided an excellent weed control measure. Grain yields at Swellendam were higher than expected, ranging from 1861 to 1989 kg/ha⁻¹.

2004

Canola production

Canola was planted in mid April at all three sites. The cultivar *Outback* was planted at Riversdale and Swellendam. *ATR Hyden* was planted at the Tygerhoek site so that Simazine could be used for weed control. Severe insect damage occurred at the Riversdale site, particularly where canola followed barley. This problem was also observed, to a far lesser extent at Tygerhoek and Swellendam and was ascribed to the higher volumes of barley stubble remaining on the soil surface from the previous season (when compared to residues that remained after other crops such as wheat and oats).

Yields of canola at Riversdale were excellent despite the low plant densities (20 to 30 plants m⁻²) with average yields of 1.95 tons ha⁻¹ and 1.72 tons ha⁻¹ for canola following wheat and barley respectively. Canola yields at the Tygerhoek and Swellendam sites were poor ranging from 0.7 to 0.9 tons ha⁻¹. Oil contents of the seed ranged from 27 to 31 at the Tygerhoek site, from 35 to 37 at the Riversdale site, and from 31 to 35 at the Swellendam site.

Lupin production

Lupins (*Tanjil*) were planted only at the Tygerhoek site. Simazine was again used to provide weed control on all plots. Average plant densities (plants m⁻²) were within the expected range (36 to 47). Lupin yields were poor relative to previous seasons but were the same or higher than the yields recorded for Canola. It should be noted that while lupins were not planted at the Riversdale research site in 2004 several production-lands were planted on the farm. Excellent yields in excess of 2.0 tons ha⁻¹ were recorded from these lands further encouraging producers that lupins were an option in the cropping systems of that region.

Wheat production

Wheat was planted at all three sites (SST 57 at Tygerhoek and Swellendam and Baviaans at Riversdale). Excellent wheat yields were recorded at Riversdale where yield following lupins (3.5 tons ha⁻¹) was higher than the yield of wheat after canola (3.2 tons ha⁻¹). It should be noted that these yields were recorded following very low total N applications for the season viz. 11 and 19 kgN/ha⁻¹ for the wheat after lupins and wheat after canola respectively.

At Swellendam the average wheat yield following lupins (1.5 tons ha⁻¹) was higher than the yield of wheat after oats (1.0 tons ha⁻¹). Average yield of wheat at Tygerhoek ranged from 1.55 to 2.23 tons ha⁻¹ with a trend showing that there was some yield benefit of rotating wheat with a legume or canola.

Hectolitre Mass (HLM) varied considerably among treatments and research sites and was negatively affected by high rainfall shortly before harvesting. While HLM for all wheat samples at Riversdale was above 77, HLM ranged from 68 to 75 and 72 to 79 at the Swellendam and Tygerhoek sites respectively. Wheat following a legume crop or canola generally had high HLM than wheat following wheat, barley or oats. These wide ranges in HLM have major effects on the quality of wheat and thus the producer price of a crop.

Crude protein (%CP) also varied widely depending on site and cropping system. At the Riversdale and Tygerhoek sites %CP was above 12% for all samples. This was also the case for wheat following lupins at the Swellendam site. However, where wheat followed oats at the Swellendam site the %CP ranged between 10.0 and 11.8 despite additional nitrogen being applied in an attempt to increase %CP of wheat grain in wheat-after-oats system.

Barley production

Barley (*Clipper*) was planted only at the Tygerhoek site. Yields ranged from 1.4 to 2.4 tons ha⁻¹. In sharp contrast to the 2003 season barley yield in the pasture-based rotation systems tended to be lower than in the continuous cropping system. Quality of grain from all sites was classed as Feed Grade due to the excessively high nitrogen contents (range from 2.1 to 2.5%). Low rainfall towards the end of the season contributed to the high nitrogen concentrations in the grain.

Oats production

Oats (*SSH 421*) was planted for silage at Tygerhoek while *SSH 405* was planted for grain at Riversdale. Dry matter yields of *SSH 421* (ave. = 4.5 ton ha⁻¹) were approximately half those reported for the 2003 season and reflect the poor climatic conditions experienced at the Tygerhoek site in 2004. Taking the oats off as hay before grass weeds (mainly ryegrass) could produce mature seeds continues to provide an excellent weed control measure for the site.

Yield of oats grain at Riversdale was excellent (2.6 tons ha⁻¹) but the

grain was classed as Feed Grade due to low HLM (43).

2005

Canola production

Canola was planted in mid April at all three sites. The cultivar *Outback* was planted at Riversdalee and Swellendam. *ATR Hyden* was planted at the Tygerhoek site so that Simazine could be used for weed control. Average plant densities at all sites were below the 'optimum' of 65 plants m⁻² but experience has shown that lower plant densities produce similar yields to the 'optimum'. There is, however, a risk of seed loss at harvesting due to uneven ripening in canola planted at low densities.

Yields of canola at Riversdalee were again relatively high being an average of 1900 kgha⁻¹. Average yields of 1100 kgha⁻¹ and 1500 kgha⁻¹ were recorded for the Swellendam and Tygerhoek sites respectively. It is of interest to note that canola yield (kgha⁻¹) was, on average, 50%, 55% and 83% of the wheat yields recorded for Tygerhoek, Riversdalee and Swellendam respectively.

Lupin production

Lupins (*Tanjil*) were planted at the Riversdalee and Tygerhoek sites. Simazine was again used to provide weed control on all plots. The average production over all four sub-camps at Tygerhoek was 2067 kg/ha. With 1500 kg/ha being the norm for ensuring positive net margins when producing lupins, the production recorded in this season again indicates the potential value of this crop as one of the main parts of a well planned crop rotation system. Lupin yields at Riversdalee were also surprisingly high (1612 to 1948 kg/ha) considering the waterlogged condition of the soils at that site. It should be noted that some lupin camps planted at commercial scale in the Riversdalee 'vlaktes' area became severely water logged resulting in stunting of the plants and subsequent poor production relative to the potential. Stunting also results in poor returns at harvest due to inaccessibility of the crop using normal harvesting equipment.

Wheat production

Wheat was planted at all three sites (SST 57 at Tygerhoek and Swellendam and SST88 at Riversdalee). Wheat yields at Riversdalee (average of 3.25 tons/ha) were similar to the yields recorded in 2004 with wheat following canola producing approximately 10% more than wheat following oats. At Tygerhoek average wheat yields ranged from 2.0 to 3.7 tons/ha with site conditions, mainly degree of water logging, appearing to have had the main influence on production.

Despite the poor soil moisture conditions at Swellendam in the latter half of the growing season wheat yields (average of 1.34 tons/ha) were higher than those recorded in 2004 following oats and within the range for wheat in 2004 after lupins reported in 2003. All wheat camps were planted after canola!

In contrast to the previous season %CP varied considerably while HLM remained stable over most treatment plots at Tygerhoek and Riversdalee. At these sites %CP had the largest effect of grain quality as measured at the silo. At Swellendam %CP remained above 12% while there was considerable variation in HLM of grain among sites. These data illustrate the significant effect that climate and soil moisture conditions

have on the quality of the product delivered at the end of the season.

Barley production

Barley (*Clipper*) was planted only at the Tygerhoek site. Average yield of barley ranged from 2.5 to 3.5 tons/ha. In contrast to the previous dry season, barley yields following pasture are similar to barley yields after wheat. On average, barley yields tended to be similar to the wheat yields recorded for 2005. The nitrogen content of kernels varied among treatments with no strong patterns indicating higher or lower %N of kernels due to previous season's crop. Most camps yielded N content of malting quality.

Oats production

Oats (*SSH 421*) was planted for silage at Tygerhoek. Mean DM yield/ha was 7.2 tons. Yield of wet material (as silage) ranged from 18.8 to 24.5 tons/ha with an average moisture content of 67%. The DM yield was approximately 1.0 ton/ha lower than recorded for 2003 but was 60% more than the average DM/ha recorded for 2004. The higher rainfall recorded for the 2005 growing season and the high soil moisture conditions, relative to the 2003 season, reduced potential DM production from the oats in 2005.

Concluding remarks

While this is a long-term project the information collected to date provides excellent information on cropping systems against which producers can monitor their own grain production systems. Many farmers and advisors have visited the trial sites over the past seasons. The Riversdalee site was again the focus point of an extremely well attended information day in 2005. Approximately 150 people attended the day.

Detailed economic analyses of the crop sequences being tested at all experimental sites for the period 2002 to 2005 to gross margin level, show clearly the economic advantages of including crops such as canola and lupins, and legume pastures, in the crop/livestock production systems of the Southern Cape.

Producers are invited to contact Mark Hardy (082 907 3392) for more information and to arrange to visit the trial site.

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