PROTEIN RESEARCH FOUNDATION

2016/2017

# RESEARCH REPORT

PROTEIN RESEARCH FOUNDATION

# Vision

The PRF strives to make a significant contribution to the promotion of local production of protein on a sustainable basis, in order to satisfy the growing demand for protein for animal production purposes as well as the optimal utilisation thereof, which will lead to an increase in the standard of living of all people in the Republic of South Africa.

# Mission

The PRF contributes to the realisation of the vision for the provision and utilisation of protein by means of the pro-active stimulation and funding of applicable purposeful research, as well as the promotion and implementation of such research results by means of technology transfer, in order to fulfil the increasing demand for protein as well as its optimal utilisation in the Republic of South Africa for animal nutrition.

The PRF subscribes to…….

- A balanced, objective approach, which is sensitive to the developmental needs of the RSA.
- A critical awareness of the latest developments regarding protein supply and utilization.
- The promotion cost-effective research.
- The dynamic promotion of the implementation of research results.
- The effective sustainable utilisation of natural agricultural resources.
- The reducing of foreign exchange payable for imports and creating of job opportunities by replacing imported protein as far as possible with locally produced protein.

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# PROTEIN RESEARCH FOUNDATION
# RESEARCH REPORT 2016/2017

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## 1. INTRODUCTION

The 1 March 2016 to 28 February 2017 financial year will be remembered for some time in agricultural communities. In the winter rainfall area canola and other winter crops performed better as the previous year, while soybeans and maize performed excellently in the summer rainfall areas with all-time record harvests. The PRF had much to be grateful for and that will be clear from this research report.

## 2. GENERAL OVERVIEW

The highlight of the previous research report was the celebration of the Protein Research Foundation's 25th Anniversary. The highlight of this year, certainly a milestone in the PRF history, was definitely the coffee table commemorative publication entitled "The development of the Protein Research Foundation".

The Board decided that the official presentation of the first copies of the commemorative book would be at a special function. In the north, the first official copy was presented to the previous PRF Chairman, Dr R Bigalke, at a function held on 4 October. At a similar function held in the south, the first official copy for that region was presented to Ms J Isaacs, CEO of the Department of Agriculture in the Western Cape (DAWC). Every person that attended the original functions was earmarked as recipients of the publication. The commemorative book is also available on the PRF web site.

Just about every organisation can report on annual events that require mentioning. Mr Joe Diekmann decided to resign as a Board Member on 5 May 2016, after 21 years of service. The PRF said goodbye to Mr and Mrs Diekmann at a gala function where he was also honoured for his contribution, particularly in terms of the poultry industry during his term of office over a period of 21 years.

The PRF policy is to nominate Board Members for respective board committees every three years. That required nomination for office for those terms that expired at the end of 2016. Dr Jos de Kock, Chairman of the Technology Committee indicated that he was available for re-nomination as a member of that committee for another term of office (three years), but not in capacity as chairman. The Board unanimously nominated Dr E

Briedenhann to replace him as Chairman of the Technology Committee. The PRF appreciated the valuable contribution of Dr De Kock as Chairman of the committee over the many years, but also for his work as a member of the Technology Committee. The Board also wished Dr Briedenhann all the very best with his new duties and responsibilities.

Another highlight of the year, especially in the canola industry, was the Canola Symposia presented (respectively) on 19 and 20 July 2016 at Bredasdorp and Paarl. The theme of the symposium was: "Growing canola with a 5-tonne yield". The particulars of this symposium are discussed in detail in this report.

Several international events left industries without words. The takeover of Monsanto by Bayer was probably the biggest of those events. That and other takeovers largely rearranged the chemical and seed industries. This will require adjustment over a few years and it will affect all that are part of these industries. The PRF will also have to adapt, because it had built good relationships with many of the role players. In some cases the events may hamper the technology flow to South Africa, but there will definitely be some positive outcomes for South Africa.

There has been a general need for a royalty system in South Africa to allow seed companies to receive compensation for specific characteristics of their cultivars. The Roundup Ready genes of the Monsanto soybeans gave rise to negative action in South Africa, even to the extent that almost no international seed company wished to register seed with new genes in South Africa.

The wheat industry took the lead and established a Section 21 company in South Africa, under the banner "South African Cultivar and Technology Agency" (SACTA). Hopefully this paved the way for other industries, including the soya and canola industries to gain access to the latest international technology that becomes available. The success of such actions is an important element for the PRF to achieve its goals for both soybeans and canola by 2020.

Like every other year, the web site development was maintained and the site was adapted (where necessary) and upgraded (see projects). The same applied to brochures and other

information documents. Board and meeting documents were made available to members in electronic format.

Videos enjoyed more attention and are available on the web site.

In an attempt to complement brochures, articles and web site information, researchers, bursary recipients and others were invited to workshops to address others on relevant subjects. We are particularly grateful to the members of the National Harvest Estimate Committee, namely Mrs Rona Beukes and Ms Marda Scheepers, as well as SAGIS' Mr Nico Hawkins who made numbers seem far more interesting during meetings.

Two foreign visits during the year included stops in several countries. Dr E Briedenhann and Prof F Meyer visited the USA, Brazil and Argentina between 2 April 2016 and 16 April 2016. They attended 14 respective appointments varying from follow-up visits to some institutions or individuals, but also new contacts that will facilitate easier future co-operation.

The Technical Committee is the link between soybean elite trial participants. Dr Jos de Kock and Mr G Scholtemeijer, as well as Mr G Keun, visited South America from 20 September 2016 to 30 September 2016. The main objective was to communicate Board policy resolutions relating to the completion of the soybean elite trials (see Board Policy Resolutions) to all involved and to address issues relating to future co-operation. All appointments showed positive results. The new INTA President, Dr A Nicora, also attended a part of the meeting with INTA and indicated that INTA wished to co-operate with the PRF over a broader front. That was very good news indeed, especially as co-operation just about came to a stand-still under the guidance of the previous INTA President.

It was also agreed with INTA that its participation in the canola elite trials should be terminated as its cultivars did not achieve good results under South African conditions.

## 3. POLICY RESOLUTIONS

The well-known elite trials for both soybeans and canola have proven the merits of the projects in more than one way. The soybean elite trials already led to the registration of several soybean cultivars in South Africa. As such, the Board decided to phase out those soybean trials within the next two years. It will remain essential to look at different ways of co-operating with foreign co-workers and maintain established relationships (see Projects for more details).

The co-operation in terms of the elite trials required annual PRF visits by some of the best soybean growers. These visits allow the exchange of very valuable knowledge. In view of that the Board decided to send our soybean experts, Messrs Wessel van Wyk and Gawie de Beer for a similar practical study visit to Estación Experimental Agroindustrial "Obispo Colombres" (EEAOC) in Argentina. The very successful visit took place during the soybean season in January 2016.

During the soybean elite trial visit of the EMBRAPA (Brazil) researchers, Dr Norman Neumaier and Dr Marcelo de Oliveira, the PRF awarded them with honorary awards, according to the Board resolution of the previous year.

The lack of a national representative body for both soya and canola in South Africa had been a significant gap for many years. After thorough deliberation over a wide front, the PRF decided to establish the South African Soybean Association, as well as the South African Canola Association. This will facilitate the establishment of reference web sites that will allow international enquiries and referrals.

## 4. SOURCES OF PROTEIN

### 4.1. International

Global environment

World compound feed production manufactured in 32 241 feed mills in 131 countries increased by 1.6% in 2015 to 995.57 million tons compound feed, which includes on farm mixing estimated at 300 million tons.

Poultry feed continues to dominate the market with an annual 3,2% growth rate and a 47% market share of global feed production.

China at 180 million tons remains the number 1 feed producing country with the USA at 174 million tons closely behind. Brazil at 69 million tons fills the 3rd position. South Africa is ranked 22 in global feed production volumes.

The trend is for the number of feed mills to decrease while feed volume continued to increase indicating a consolidation to capitalize on economies of scale.

The production of the main raw materials for animal feed namely maize and soybeans remained at high levels and this trend is expected to continue. Global maize production reached levels of 969 million tons in 2015-2016 but is expected to increase in 2016/17 to over a billion tons.

The production of soybeans in 2015-2016 is forecast at 312 million tons down from 320 million tons in the previous year. Production in 2016-2017 is expected to increase, global consumption is however also likely to increase to as much as 324 million tons which could cause a slight firming in prices.

South Africa

The business environment in 2016 was extremely difficult for the grain and oilseed sector with ramifications filtering through to the feed industry, the severe drought caused by El Niño resulting in very low crop productions. The two main ingredients of the feed industry namely maize and soybeans increased dramatically in price due to the shift in supply and demand dynamics. Increases in import volumes of soybeans, soybean meal and maize resulted in prices considerably higher than the previous year. The feed industries volumes also came under threat with the implementation of the African Growth and Opportunity Act (AGOA) requiring 65 000 tons to enter South Africa duty free in addition to the escalating duty-free volume entering South Africa from Europe.

Imported poultry meat was 560 155 tons for 2016 as compared to 2015: an increase of 17% year on year, negatively affecting local poultry production requirements with consequent reductions in feed production.

Feed volumes reported by Animal Feed Manufacturers Association (AFMA) was down year on year in December by 5.3%, extrapolated to end of March 2017 this would result

in an annual feed production of 6.6 million tons compared to 6.9 million tons for 2015-2026, which would reflect a 4.3% reduction year on year. National feed production is expected to decrease by over 5% year on year. The updated national feed consumption figures will be available last half 2017.

Maize consumption in animal feed decreased up to April 2017 to 5 million tons from 5,52 million tons the previous year: a decrease of 10,4% (SAGIS).

Oilcake consumption for AFMA members has decreased from 1.044 to 1.008 million tons from December 2015-2016 to December 2016-2017. Soybean meal consumption likewise decreased from 708 thousand to 687 thousand tons, a decrease of 3%.

## 4.2. Local protein production

### 4.2.1 General

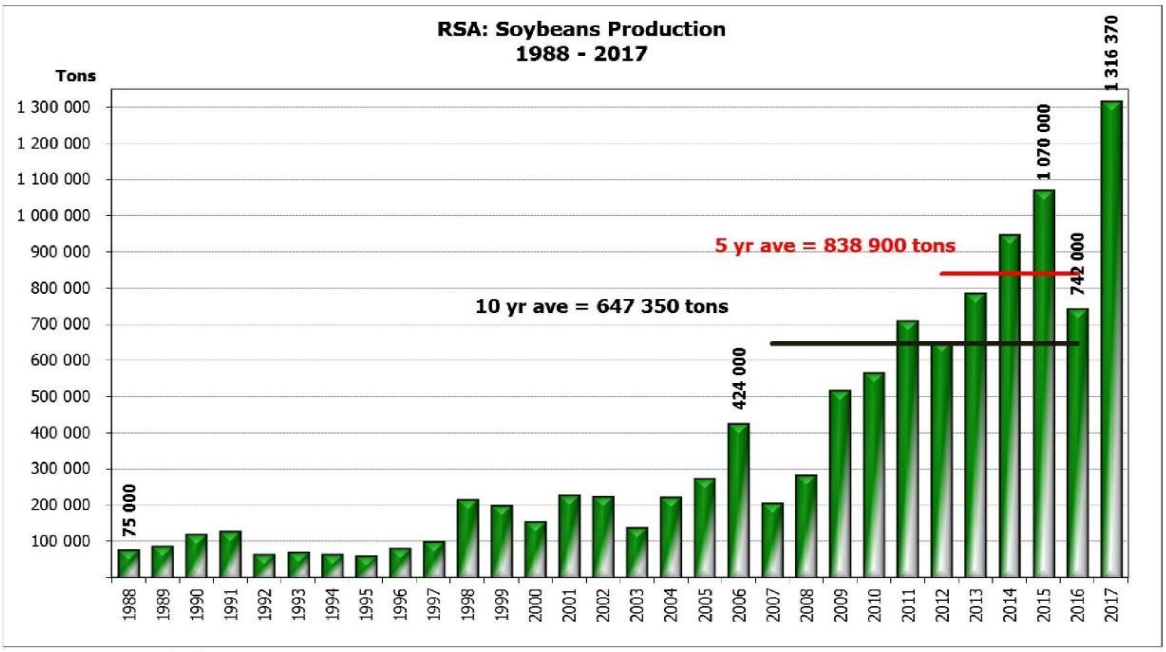
For several decades plant protein remains the largest source of animal feed protein in South Africa. Sunflower remained a mainstay for many years, while soybeans now fill the same scope as sunflower. During the past year the record soybean harvest of 1,3 million tonnes surpassed the best sunflower harvest ever for the very first time. Based on yield per hectare, sunflower remains in a better position than soybeans. Cotton and canola complement these well, while fish meal is used only where truly necessary, mainly due to price.

### 4.2.2 Soybeans

The soybean industry experienced three extreme years (see Graph 1). In 2014/15 soybeans were produced on 687 300 hectares, then the largest area ever in South Africa. Production was more than one million tonnes for the first time ever (1 070 000 tonnes). That year was followed by an abnormally dry year, resulting in a yield of only 742 000 tonnes. Then, in 2016/17, all previous records were broken with a harvest of 1 316 370 tonnes produced on 573 950 hectares. That is a yield of 2,29 tonnes per hectare, the highest yield ever. The only other time where the average yield per hectare exceeded 2 tonnes per hectare, was 2,17 tonnes per hectare in 2008/09 (see Graph 2).

The relationship between soybeans and maize planted as rotation crops provide a good indication of the potential expansion of soya production per specific region. The PRF feels that the first objective should be a 70:30 ratio (see Figure 3). This figure provides a good indication of the current position, both per province and for South Africa as a whole. Although KwaZulu-Natal and Mpumalanga can handle expansion, the biggest potential remains in the Free State and North West Province. An increase from 17% to 34% in the Free State implies doubling the hectares and tonnage, requiring an additional 240 000 hectares and 500 000 tonnes soybeans. If the current 82:18 ratio (2017) were increased to 70:30, it will mean a production of 956 666 hectares soybeans. However, the North West Province attracts most attention and after the success achieved over the past year, we expect a significant expansion of soybean planting in the North West Province (see Figure 3).

***Graph 1***

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***Graph 2***

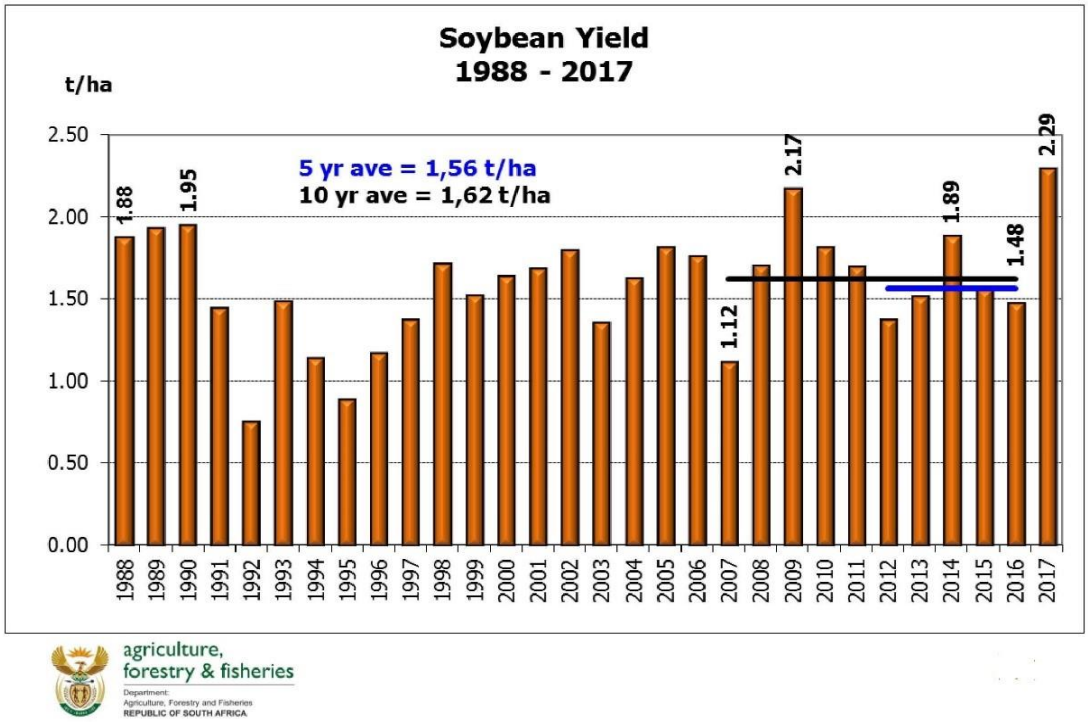
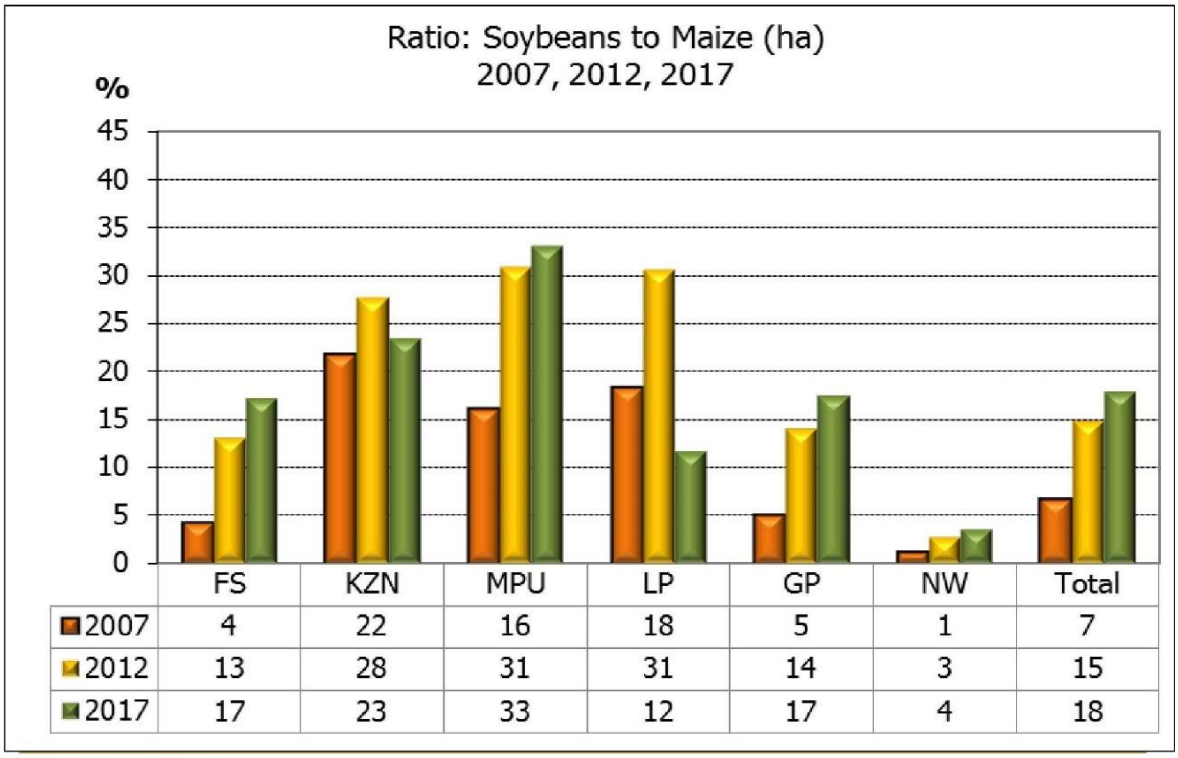



***Figure 3***




| | FS | KZN | MPU | LP | GP | NW | Total |
|---|---|---|---|---|---|---|---|
| 2007 | 4 | 22 | 16 | 18 | 5 | 1 | 7 |
| 2012 | 13 | 28 | 31 | 31 | 14 | 3 | 15 |
| 2017 | 17 | 23 | 33 | 12 | 17 | 4 | 18 |

Weigh and Win Competition

This maize and soya competition was presented and managed by Du Pont/Pioneer in the summer rainfall area. It was supported and strengthened by the participation of John Deere, Syngenta, Sanlam, Santam, First National Bank and Senter 360. It was also supported by the PRF.

In spite of an extremely dry year (driest in 93 years) in South Africa, various producers participated in the competition. For soybeans there were four (4) categories and large prizes.

The soybeans winners were:

1) Soybean under irrigation

   Gerrit Roos - Belfast - 5,23 tonnes/ha

2) Soybeans dry land - East

   Pieter van Vuuren - Standerton - 3,96 tonnes/ha

3) Soybeans dry land - West

   Armand de Villiers - Fochville - 3,0 tonnes/ha

4) Soybeans KwaZulu-Natal

   MW Stein - Dundee - 4,03 tonnes/ha

This competition encourages producers to think innovatively to achieve the highest yield per hectare.

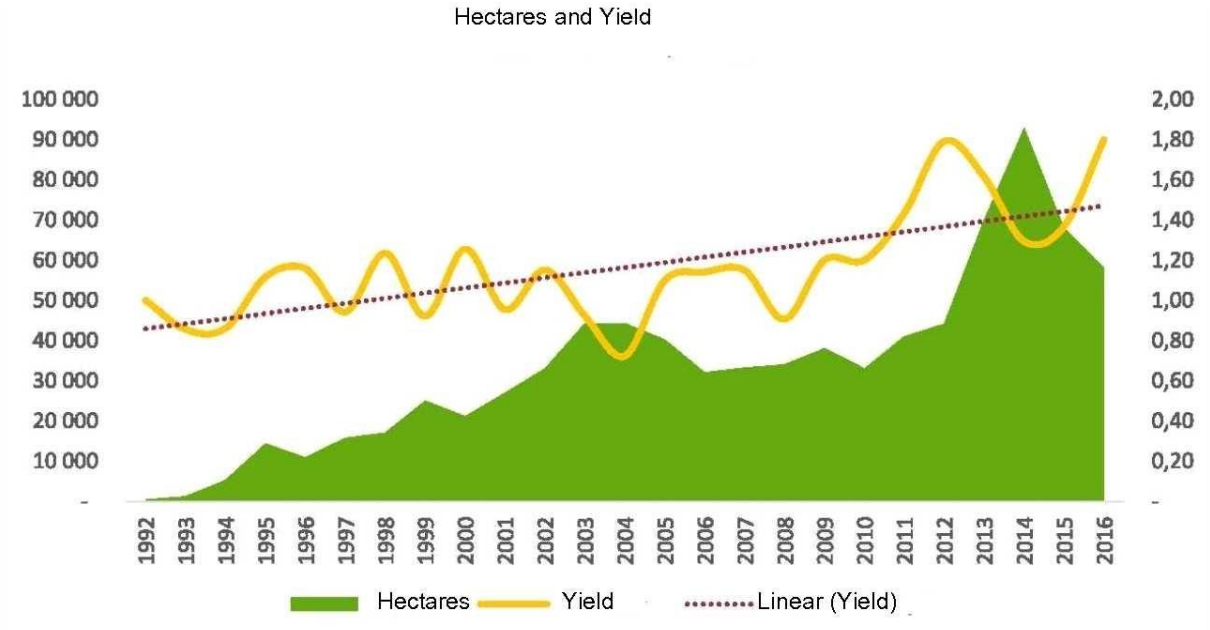
The competition will be continued in 2017/18.

### 4.2.3 Canola

Introduction

The 2016 canola production season was marked by insecurities, expectations and a "grand finale" for the Western and Southern Cape regions. It certainly was a year that showed and reconfirmed canola's ability to recover from extreme drought conditions. The highlight was the highest average yield ever of 1,82 tonnes per hectare for the Southern Cape and 1,71 tonnes per hectare for the Swartland. It brought the total delivered tonnes to 105 460 tonnes.

***Figure 1: Canola area and yield since 1992***




*Plantings*

The 2016 canola planting was lower than that of the 2015 season, mainly due to the increased demand for barley in the Southern Cape area and uncertain rainfall in the Swartland. A total of 68 075 hectares was planted, compared to the 78 050 hectares of 2015. A comparison of the rainfall figures for the two areas confirm the exceptional canola ability to survive drought conditions and recover sufficiently to deliver record yields. Figures 2 and 3 respectively show the rainfall figures for Langgewens and Tygerhoek. Irrespective of good rainfall in March and April, which ensured good planting conditions

and establishment opportunities between 1 May and 8 June, very little rainfall occurred. The canola survived these conditions and recovered extremely well.

***Figure 2: Monthly and annual rainfall at Langgewens for 2016 and long-term***

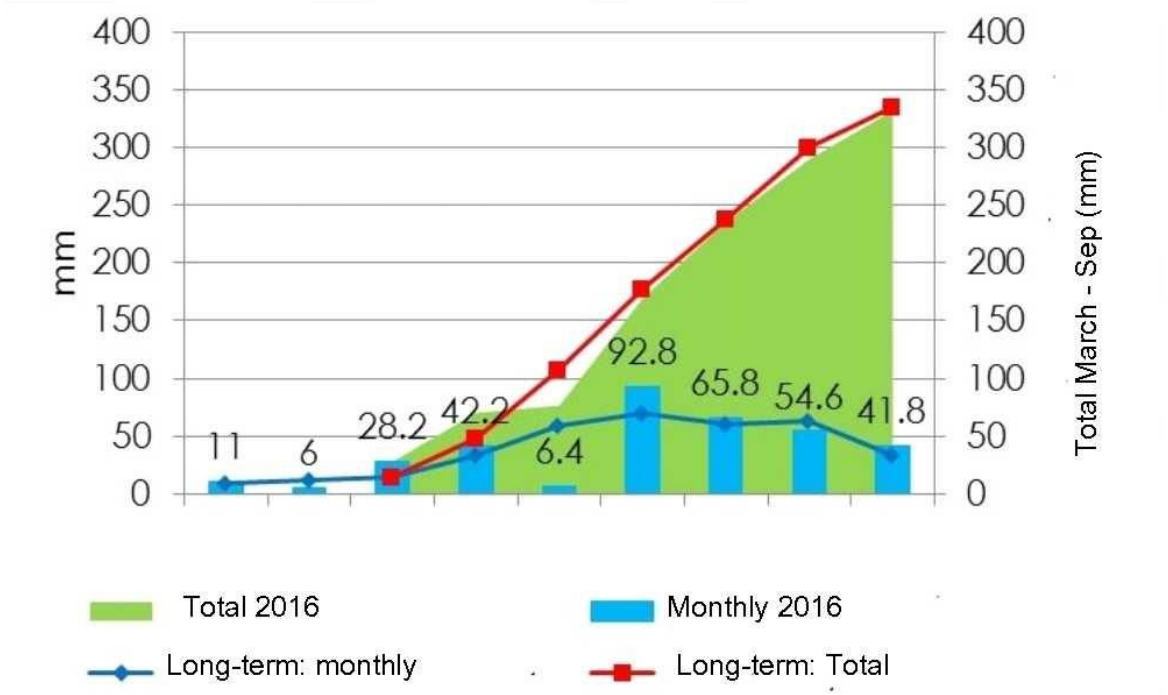



***Figure 3: Monthly minimum and maximum temperatures at Tygerhoek for 2016 and long-term***

Cultivar evaluation and seed yield results

The information for Swartland and Rûens in 2016 confirms the exceptional yields achieved.

***Table 1 - Swartland Seed Yields - 2016***

| | Langgewens | | Darling | | Eendekuil | | Philadelphia | | Grasrug | | Swartland | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Belinda** | 3889 | b | 2181 | bcdef | 2142 | bcd | 1721 | def | 2981 | cde | 2798 | cde |
| **CB Agamax** | 3796 | bc | 2393 | abcd | 2092 | bcde | 2134 | abc | 3034 | bcd | 2829 | cde |
| **CB Tango** | 3889 | b | 2158 | bcdef | 2237 | abc | 1685 | def | 3149 | bc | 2858 | bcd |
| **Hyola 50** | 3858 | b | 2469 | abc | 1947 | cdefg | 2001 | abcd | 3036 | bcd | 2828 | cde |
| **Diamond** | 4289 | a | 2330 | abcd | 2380 | ab | 2257 | ab | 3480 | a | 3120 | a |
| **CHYB2644** | 4355 | a | | | | | | | | | | |
| **Konv.-gem.** | **4013** | | **2306** | | **2160** | | **1959** | | **3136** | | **2887** | |
| **44Y84** | 3014 | f | 1971 | cdef | 2032 | cdef | 1632 | ef | 2595 | f | 2403 | g |
| **44Y87** | 3375 | def | 2265 | abcde | 1893 | defg | 1175 | g | 3175 | bc | 2677 | def |
| **44Y89** | 3763 | bc | 2354 | abcd | 2451 | a | 1950 | abcde | 3037 | bcd | 2901 | bc |
| **44Y90** | 3870 | b | 2463 | abc | 2075 | cdef | 1928 | bcde | 3338 | ab | 2936 | abc |
| **45Y88** | 3674 | bcd | 2537 | ab | 1913 | defg | 1805 | bcde | 3287 | ab | 2853 | cd |
| **45Y91** | 3849 | b | 2713 | a | 2015 | cdef | 2281 | a | 3577 | a | 3038 | ab |
| **Hyola 575 CI** | 3863 | b | 1710 | f | 1906 | defg | 2096 | abc | 3159 | bc | 2660 | ef |
| **Hyola 577 CI** | 3476 | cde | 1788 | ef | 1716 | g | 1630 | ef | 3041 | bcd | 2505 | fg |
| **43Y85** | | | 2229 | abcde | 1799 | fg | 1949 | abcde | 2920 | cde | | |
| **CL-gem.** | **3611** | | **2225** | | **1978** | | **1827** | | **3151** | | **2747** | |
| **CB Atomic HT** | 3529 | bcde | 1774 | ef | 1847 | efg | 1670 | def | 2872 | cdef | 2505 | fg |
| **Hyola 555 TT** | 3546 | bcde | 1710 | f | 2003 | cdefg | 1546 | f | 2781 | def | 2510 | fg |
| **Hyola 559 TT** | 3362 | def | 1921 | def | 2073 | cdef | 1745 | def | 2726 | ef | 2520 | fg |
| **Granite TT** | 3249 | ef | | | | | | | | | | |
| **TT-gem.** | **3421** | | **1801** | | **1974** | | **1654** | | **2793** | | **2512** | |
| **Proef gem.** | 3703 | | 2174 | | 2031 | | 1835 | | 3079 | | 2746 | |
| **kv** | 6.02 | | 13.89 | | 8.63 | | 11.44 | | 5.93 | | 185.62 | |
| **kbv** | 369.8 | | 502.36 | | 291.58 | | 349.29 | | 304.27 | | | |

***Table 2 - Rûens – Seed Yields - 2016***

| | Napier | | Klipdale | | Riversdal | | Swellendam | | Witsand | | Suid-Kaap | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Belinda** | 3530 | ab | 3469 | ab | 2773 | abcde | 3697 | a | 2568 | bcd | 3207 | abc |
| **CB Agamax** | 3226 | bcde | 3274 | bcd | 2808 | abcd | 2997 | bcde | 2436 | d | 2948 | de |
| **CB Tango** | 2908 | cdefg | 2506 | fg | 2511 | cdef | 2899 | de | 2466 | cd | 2658 | fgh |
| **Hyola 50** | 2783 | efg | 2697 | ef | 2355 | defg | 3420 | abc | 1922 | h | 2635 | fgh |
| **Diamond** | 3333 | bc | 3234 | bcd | 3242 | a | 3749 | a | 2967 | a | 3305 | ab |
| **CHYB2644** | 3262 | bcd | | | 2587 | cdef | | | | | | |
| **Konv.-gem.** | **3174** | | **3036** | | **2713** | | **3353** | | **2472** | | **2951** | |
| **44Y84** | 3036 | cdef | 3001 | cde | 2415 | cdefg | 2703 | e | 2182 | efg | 2667 | fgh |
| **44Y87** | 2958 | cdef | 3216 | bcd | 1968 | g | 3426 | abc | 2080 | gh | 2730 | fg |
| **44Y89** | 2950 | cdefg | 3276 | bcd | 3165 | ab | 3702 | a | 2685 | b | 3156 | bc |
| **44Y90** | 3521 | ab | 3253 | bcd | 2864 | abc | 3753 | a | 2660 | bc | 3210 | abc |
| **45Y88** | 3291 | bc | 3532 | ab | 2592 | cdef | 3702 | a | 2383 | de | 3100 | cd |
| **45Y91** | 3938 | a | 3780 | ab | 2863 | abc | 3481 | ab | 2777 | ab | 3368 | a |
| **Hyola 575 CI** | 2996 | cdef | 2481 | fg | 2730 | bcde | 3312 | abcd | 2445 | cd | 2793 | ef |
| **Hyola 577 CI** | 3129 | bcdef | 2950 | de | 2358 | defg | 3356 | abcd | 2163 | fg | 2791 | ef |
| **43Y85** | 2774 | fg | 2728 | ef | | | 2770 | e | 2362 | def | | |
| **CL-gem.** | **3177** | | **3135** | | **2619** | | **3356** | | **2415** | | **2977** | |
| **CB Atomic HT** | 2838 | defg | 2585 | fg | 2311 | efg | 3084 | bcde | 2140 | g | 2592 | gh |
| **Hyola 555 TT** | 2771 | fg | 2485 | fg | 2391 | cdefg | 2748 | e | 2191 | efg | 2517 | h |
| **Hyola 559 TT** | 2803 | efg | 2348 | fg | 2368 | defg | 2921 | cde | 2005 | gh | 2489 | h |
| **Granite TT** | 2500 | g | | | 2172 | fg | | | | | | |
| **TT-gem.** | **2728** | | **2473** | | **2310** | | **2918** | | **2112** | | **2533** | |
| **Proef gem.** | **3081** | | **2989** | | **2582** | | **3278** | | **2378** | | **2885** | |
| **kv** | 8.85 | | 6.53 | | 11.04 | | 0.38 | | 5.48 | | 180.29 | |
| **kbv** | 451.61 | | 324.95 | | 473.16 | | 511.41 | | 216.99 | | | |

The variety of highly competitive cultivars, conventional, TT (Triazine Tolerant) and CL (Clearfield) made available to producers, was a milestone for the PRF. It improved relationships built with institutions in Australia, Europe and Canada. It also produced the desired results. South African producers certainly no longer depend on second best cultivars.

The competitive yields of the TT and particularly the CL cultivars, including the conventional cultivars were particularly noticeable. Focus is definitely on CL hybrid cultivars, not only for better yield ability, but also for better vitality and weed control characteristics.

Roundup Ready cultivars will no doubt be capable of playing a significant role, particularly in the Swartland where the management of herbicide resistant rye grass is fast becoming an increasing problem.

Seed availability

The availability of sufficient seed of the best achieving cultivars no longer seems to be such a big problem. Seed orders are and remain a challenge for the seed companies as orders need to be placed at least a year in advance. Canola assumed its rightful place as cash rotation crop at the most canola producing farms. For those farmers advance seed orders are no longer a big problem.

Disease management

Producers are continuously informed of disease control through articles and Canola Focus. Producers are being informed of the use of cultivars with good black stem resistance. It did not seem to be a big problem in 2016.

The management and control of *Sclerotinia* are significant factors that contribute to yield reduction. Spraying the crop with Prosaro is done prophylactically and a follow-up spraying is determined by climate/rainfall. Various articles were published in the media and Canola Focus. Producers are also informed during training discussions with chemical representatives. *Sclerotinia* training is a focus area of the Canola Planning Committee and it remains a huge challenge.

Canola Symposium - 2016

The Canola Symposium held on 19 July 2016 at Agri Mega in Bredasdorp and on 20 July 2016 at Kronenburg, Paarl, were the canola highlights of 2016. The complete programme and all papers are available on the PRF web site. The presentations were excellent, educational and provided guidelines. All role players submitted positive comments.

***Table 3 – Canola Symposium - 2016 Programme***

Technology transfer and training

Six issues of Canola Focus were published in 2016, each containing articles and information relevant to successful canola growing. This work handled by Prof André Agenbag, Messrs Piet Lombard, Jannie Bruwer and Ms Izane Leygonie is invaluable for canola producers.

Various articles appeared in Landbouweekblad, Landbou Burger and other popular media publications. These publications are used very successfully to address current issues that may affect production. Prof André Agenbag's articles on fertilisation and surface fertilisation for canola, Mr Chris Cumming's articles on weed control and *Sclerotinia* control are but a few examples of the information in Canola Focus. The results achieved with canola production follow sustained education, training and the distribution of information.

The training and relationships with chemical representatives is of critical importance and in 2016 a training opportunity was arranged for the Southern Cape. The interest and attendance was very positive, with lively interaction.

***Table 3 – Canola Symposium - 2016 Programme***

PROTEÏENNAVORSINGSTIGTING
PROTEIN RESEARCH
TRUST 5802/94

**PROGRAM**

**PNS Canola-Opleidingsdag: 19 Februarie 2016**

**Koringaarsaal, OverberAgri, Caledon**

**Tema: Bestuursaspekte vir maksimum opbrengste**

| | |
|---|---|
| 09h00 - 09h30 | Registrasie, Tee \ koffie en toebroodjies |
| 09h30 - 10h00 | Verwelkoming en inleiding<br>*Mnr Andries Theron, O/Voorsitter PNS* |
| 10h00 - 10h40 | Cultivarkeuse en riglyne vir vestiging<br>*Mnr Piet Lombard, Departement Landbou Wes-Kaap* |
| 10h40 - 11h20 | Bemestingaspekte van belang<br>*Prof André Agenbag, PNS* |
| 11h20 - 12h00 | Die invloed van onkruiddoders op opvolggewasse<br>*Mnr Chris Cumming, PNS* |
| 12h00 - 12h30 | Sclerotiniabeheer<br>*Mnr Jannie Bruwer, Bayer AgriScience* |
| 12h30 - 13h00 | SOILL terugvoering oor 2015 oes, asook tydigheid van platsny<br>*Mnr Franco le Roux, SOILL* |
| 13h00 - 13h10 | Bedankings<br>*Mnr Gerhard Scholtemeijer, Voorsitter PNS* |

**MIDDAGETE**

Canola in the summer rainfall area

The PRF started official canola trials in the summer rainfall area. The localities, Groblersdal and Beestekraal were selected for this new action.

The trials involve four cultivars and three planting dates under irrigation. These are handled by Mr Willie Jonker (PRF contractor). The four cultivars are the best chosen from a previous cultivar trial planted as pilot trial. The cultivars cover different growing season durations (one short growing season, two medium to short growing seasons and one medium growing season). The planting dates represent a planting window that could fit the current crop production system.

In the 2016/17 season a high yield of 5,8 tonnes/ha was achieved and the 2017/18 season promises even better yields.

If these trials are successful, it could lead to new crop choices for producers and it could contribute largely to a higher income per hectare.

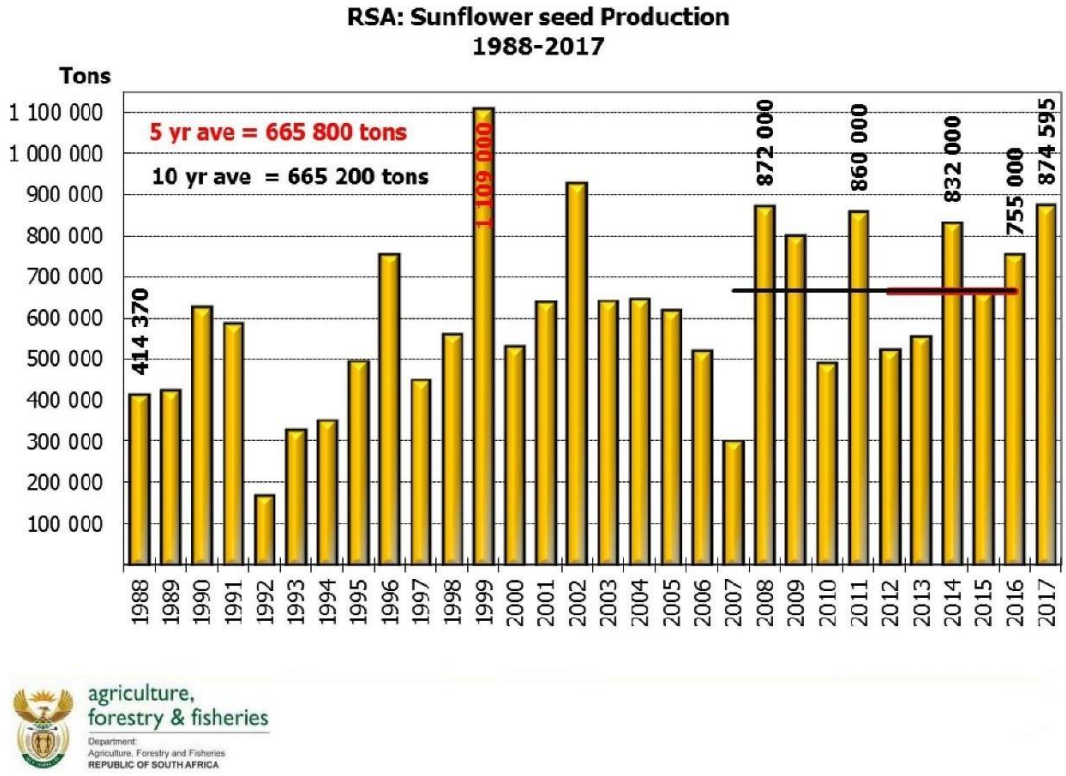
The results of the canola yield competition are included under projects mentioned elsewhere in this report.

### 4.2.4 Sunflower

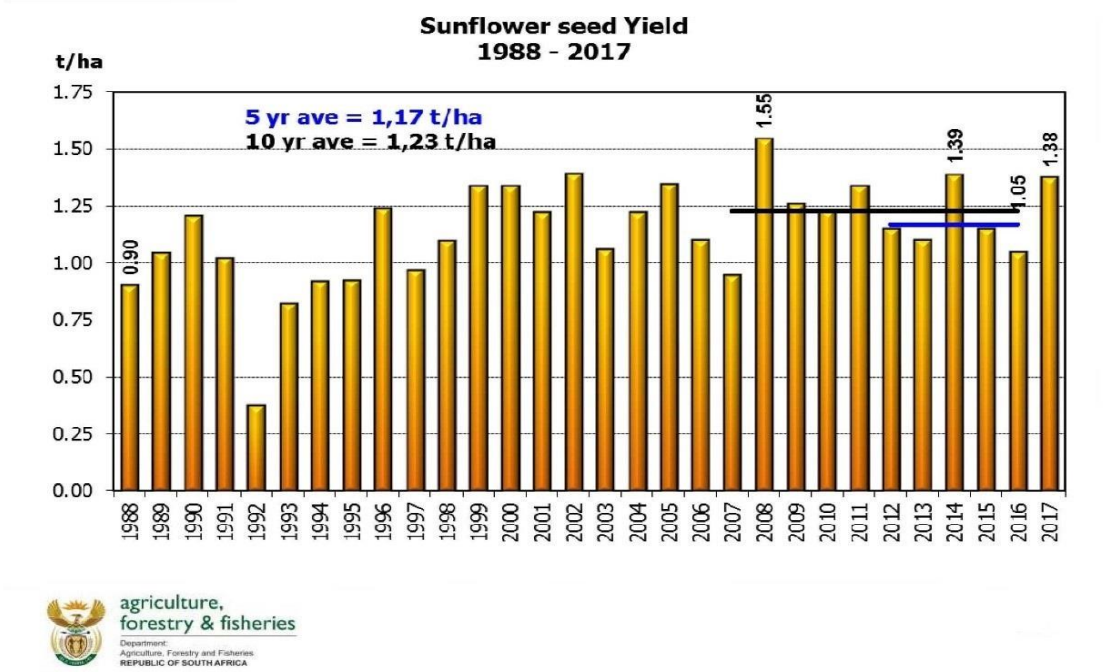
Last year's research report indicated that sunflower is a crop with a yield increase or decrease that depends on climate conditions. The past two years are typical examples of this trend. In 2015/16, 755 000 tonnes sunflower was produced on 718 000 hectares, while 2016/17 was a good year that followed the previous averages and 874 595 tonnes were produced on 635 750 hectares. It is shown in Graph 1. The same graph shows that there was very little deviation in the yield averages for the previous five years and 10 years. This is also clear from Figure 2 that shows yield per hectare over several years.

The Free State remains the province with the larges area planted under sunflower, at about 400 000 hectares in 2015/16 and 330 000 hectares in 2016/17. In both cases more than 50% of the total area had been planted under sunflower. North West Province is in the second place, but no other province comes close to these two provinces, irrespective of surface or yield per hectare.

***Graph 1***




***Graph 2***



### 4.2.5 Other sources of protein

During 2016-2017 South African soybean production was 741 550 tons and sunflower seed 755 000 tons. The industry for the year ending February 2017 processed the local soybean crop plus the imported 271 098 tons, with 852 308 tons soybeans going to oilseeds crushing (average of 71 000 tons per month), 98 718 tons to full fat soya and 23 875 tons to human consumption.

Soybean prices for the year trended to import parity rather than export parity mainly due to drought affecting the soybean crop size. Crush margins for soybeans was extremely poor during 2016. The soybean crushing industry went through a difficult year. The large estimated soybean crop size of 1 340 370 tons for 2017-2018 will relieve this situation and healthy crush margins can be expected.

The South African feed industry except for one single feed milling company has embraced the quality of many local oilseed crushers, experiencing good results with soybean meal at a considerable discount to imported soybean meal. This scenario results in significant benefits to an ailing animal feed and poultry industry in South Africa.

The sunflower crushing industry crushed 695 470 tons for the year ending February 2017 (average of 58 000 tons per month average). Crush margins for sunflower were on average significantly better than soybeans. The large crop estimate of sunflower for 2017 of 821 970 tons will eliminate the requirement for sunflower oilcake imports as well as increase crush margins and lower sunflower oilcake prices to feed mills.

## 4.3. Oil Crushing Industry

### 4.3.1 Producers of full fat soya

The use of full-fat soya in the animal industry remains a given. The quantities vary from year to year, depending on the total availability of mainly protein sources. During the past year, 98 722 tonnes full-fat soy was produced, 18,9% less than the 121 763 tonnes produced for the corresponding previous period.

### 4.3.2 Oil Crushing Industry

Oilseed processors

During 2016/17 the South African soybean production was 741 550 tons and sunflower seed 755 000 tons. The industry processed for the year ending February 2017 the local soybean crop plus the imported 271 098 tons, 852 308 tons soybeans going to oilseeds crushing (average of 71 000tons per month), 98 718 tons to full fat soya and 23 875 tons to human consumption.

Soybean prices for the year trended to import parity rather than export parity mainly due to drought affecting the soybean crop size, crush margin for soybeans was extremely poor during 2016. The soybean crushing industry went through a difficult year. The large estimated soybean crop size of 1 340 370 tons for 2017/18 will relieve this situation and healthy crush margins can be expected.

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## 4.4. Protein consumers

### 4.4.1 Animal feed manufacturers

Global environment

World compound feed production manufactured in 32 241 feed mills in 131 countries increased by 1.6% in 2015 to 995.57 million tons compound feed, including on farm mixing this figure is estimated at 1.4 billion tons.

Poultry feed continues to dominate the market with an annual 3,2% growth rate and a 47% market share of global feed production.

China at 180 million tons remains the number 1 feed producing country with the USA at 174 million tons closely behind. Brazil at 69 million tons fills the 3rd position. South Africa is ranked 22 in global feed production volumes.

The trend is for the number of feed mills to decrease while feed volume continued to increase indicating a consolidation to capitalize on economies of scale.

The production of the main raw materials for animal feed namely maize, meat and soybeans remained at high levels and this trend is expected to continue. Global maize production reached levels of 969 million tons in 2015/16 but is expected to increase in 2016/17 to over a billion tons.

The production of soybeans in 2015/16 is forecast at 312 million tons down from 320 million tons in the previous year. Production in 2016/17 is expected to increase, global consumption is however also likely to increase to as much as 324 million tons which could cause a slight firming in prices.

South Africa

The business environment in 2016 was extremely difficult for the grain and oilseed sector with ramifications on filtering through to the feed industry. The severe drought caused by El Nino resulting in very low crop productions. The two main ingredients of the feed industry namely maize and soybeans increased dramatically in price due to the shift in supply and demand dynamics. Increases in import volumes of soybeans, soybean meal and maize resulted in price considerably higher than the previous year. The feed industries volumes also came under threat with the implementation of African Growth and Opportunity Act (AGOA)requiring 65 000 tons of chicken to enter South Africa duty free in addition to the escalating duty-free volume entering South Africa from Europe.

Imported poultry meat was 560 155 tons for 2016 as compared to 2015 an increase of 17% year on year. Negatively affecting local poultry production requirement and consequent reduction if feed production.

Feed volume reported by Animal Feed Manufacturers Association (AFMA) was down year on year in December by 5.3%, extrapolated to end of March 2017 this would result in an

annual feed production of 6.6 million tons compared to 6.9 million tons for 2015/26, this would reflect a 4.3% reduction year on year. National feed production is expected to decrease by over 5% year on year. The updated national feed consumption figures will be available last half 2017.

Maize consumption in animal feed decreased up to April 2017 to 5 million tons from 5,52 million tons the previous year a decrease of 10,4% (SAGIS).

Oilcake consumption for AFMA members has decreased from 1.044 to 1.008 million tons from December 2015/16 to December 2016/17. Soybean meal consumption likewise decreased from 708 thousand to 687 thousand tons, a decrease of 3%.

### 4.4.2 Poultry, pigs and other consumers of protein

#### 4.4.2.1 South African Poultry Association (SAPA)

Prof Gous reported that the local poultry industry is collapsing and that many negative factors were having a negative impact on the poultry industry. He said that the operational organisation was suffering in a difficult period. The Chief Executive Officer resigned from his position and the acting head struggles to cope. He mentioned that both Rainbow and Astral suspended their membership of the organisation.

#### 4.4.2.2 Broiler Organisation

The South African Poultry Industry has had arguably the worst year in its history. Final import numbers for 2016 were 560 000 tonnes of poultry products, amounting to R5.5 billion, and 240 000 tonnes of bone-in portions, worth R3.6 billion. The total imports are 1.3 times the size of Astral, our largest broiler producer. As a result, RCL Foods (Rainbow Chicken Limited) had to close a third of its production facilities and retrench 1300 of its employees. Many of the smaller broiler producers who were selling non-specialised products have now exited the Industry also, leading to many more job losses.

It has been proven that the South African broiler industry can produce slaughtered whole broilers for less than most of the European countries, in spite of the higher cost of maize and soybeans paid by our producers. It is therefore not that we are less efficient in producing broilers, but that the EU countries are dumping unwanted meat on us. The

imported meat is being sold at the same price, and higher, as that being charged by local producers, so not even the general public is benefiting from these imports.

The Poultry Industry worldwide has been in turmoil. Avian Influenza (AI, or Bird Flu) first made an appearance in Europe at the end of October 2016 and soon spread to 17 European countries. Compulsory culling of poultry first took place in Hungary, France and Ireland, and then Russia. Millions of birds have also been culled in Japan and China to try and prevent the spread of the disease. And then in the early part of 2017 four states in the US, including Georgia, reported outbreaks of AI. Brazil exports were also hit hard by a scandal involving the export of salmonella-contaminated meat as well as broiler meat containing pig heads, acid to hide the smell of rotten meat, and cardboard.

One wonders whether the imports of chicken meat into South Africa will continue if these countries cannot eradicate the disease; in which case the cost of broiler meat will soar given the decline in local broiler production.

Legislation to limit the amount of brine added to processed broilers to 15% placed a further burden on the Industry.

The situation in the poultry industry could have been very different had there been a concerted effort on the part of the industry to export chicken breasts to the rest of the world. The beef industry appears to have been successful in its export initiative, and the pork industry also is increasing the amount of meat being exported from South Africa.

Unlike the poultry industry, the pork industry has had a profitable year and this is likely to continue into 2017. Pork prices have increased as a result of a reduction in the number of pigs slaughtered (from about 240 000 pigs in November 2015 to about 215 000 in October 2016) and the reduced cost of maize and soya has resulted in lower feed prices. High beef prices have enabled pork prices to remain high, and this situation is likely to continue whilst the cattle herd is being rebuilt after the drought experienced over the past three years. Internationally the price of pork fell during the year, but because of the weaker Rand the amount of pork imported into the country remained constant, and exports increased by 5% during the year.

#### 4.4.2.3 South African Pork Producers Association (SAPPA)

In contrast with the poultry industry, the pork industry had a profitable year that is likely to continue in 2017. Pork prices increased due to the reduction in the number of slaughtered pigs (about 240 000 in November 2015 to about 215 000). The lower maize and soybean prices also gave rise to lower feed prices. Higher beef prices helped to keep the pork price high and this trend will probably continue while farmers re-establish their cattle herds after the drought of the past three years. The international pork price fell during the year, but due to the weaker rand value, the imported pork quantities remained constant, while exports increased by 5% during the year.

### 4.4.3 Human consumption

During 2016 the Marketing of Agricultural Products Act of 1996 (Act 47 of 1996) was amended. Statutory measures were implemented to enforce the submission of monthly production reports to SAGIS. The reports are required for oilseed production for both human and animal consumption. According to the SAGIS article entitled, “Soybean Flours and Meals/Textured Vegetable Protein”, it is clear that the generally accepted number of just over 2 000 tonnes products per month that was mainly earmarked for the bakers’ industry, really amounts to just more than 3 000 tonnes per month. As such it is safe to assume that soybean products for human consumption (excluding edible oil), is between 36 000 and 40 000 tonnes per year. The Oilseeds Advisory Committee (OAC) and the Oil and Protein Seeds Development Trust (OPDT) currently fund several projects to promote soybean products for human consumption.

## 5. PROJECTS FINANCED 2016/17

The Protein Research Foundation funded 16 research projects in 2016/2017 (See Annexure 1). This was one project more than the previous year. Two (2) of the 16 projects were new projects, while 14 were continuations of existing projects. The total number of funding applications was 16. Of those only one (1) project was not approved.

Three (3) projects (See Annexure II) were completed during the year, but the final reports are expected only by the first half of 2017.

For 2017/18, 17 applications were received. Two (2) were new applications. These applications will be described fully in the next research report.

## 6. PROJECTS COMPLETED SUCCESSFULLY OR THAT SHOWED PROGRESS (ANNEXURES I AND II)

### 6.1 EVALUATION OF PRF SOYBEAN ELITE LINES UNDER SOUTH AFRICAN CONDITIONS; GP De Beer and WF van Wyk, Contractors, Protein Research Foundation

The PRF soybean elite trials (2016/17) were planted at the following six (6) localities:

- Stoffberg - Representing the northern Highveld (cool area);
- University of Pretoria (Hatfield) - Representing the southern Highveld (moderate to warm area);
- Brits - Representing the northern irrigation area (warm area);
- Potchefstroom - Representing the western production area (moderate to cool area);
- Bethlehem - Representing the eastern and northern Free State (cool area);
- Ukulinga (Pietermaritzburg) - Representing KwaZulu-Natal (warm area).

The following four (4) local cultivars were used as standards for the trials:

| | | |
|---|---|---|
| LS 6240 R | - | M.G 4.0 |
| DM 5953 RSF | - | M.G 5.0 |
| LS 6164 R | - | M.G 6.0 |
| NS 7211 R | - | M.G 7.0 |

Seed institutions of South America (Argentina, Uruguay and Brazil) entered 58 elite soybean lines that were evaluated with the four (4) standards at the six (6) localities according to grain yield and general adaptation to South African conditions. The maturity groups (M.G) varied between M.G 4.0 to M.G. 7.4. The trial at Ukulinga was controlled preventively, using registered fungicides, against soybean rust.

A number of the 58 lines produced relatively high grain yields of 5 716 kg/ha, 5 702 kg/ha and 5 084 kg/ha. The best overall yield was produced in Pretoria (UP) by the control DM 5953 RSF at 6 335 kg/ha.

The project creates the opportunity for participating institutions to test their materials and to consider local registration of cultivars. As such it expands the choice of soybean cultivars in South Africa to the benefit of soybean producers and the soybean industry in general.

## 6.2 ETIOLOGY AND POPULATION STRUCTURE OF *MACROPHOMINA PHASEOLINA* (CHARCOAL ROT) IN SUNFLOWER AND SOYBEANS IN SOUTH AFRICA;

**E Jordaan and JE van der Waals, University of Pretoria**

This project investigates interactions between the environment, host (sunflower and soybeans) and *Macrophomina phaseolina* causing charcoal rot in South Africa. The main objective of this work is to understand the drivers of this disease in order to develop a decision support system for charcoal rot management. *In vitro* trials, pathogen identification, characterization and greenhouse pot trials will be used to create a holistic picture of charcoal rot on in SA. The results from the *in vitro* trials have been discussed in previous reports. Unfortunately, the planned grower survey had to be removed as we were unable to obtain enough feedback to make statistically sound conclusions regarding growers' perceptions, the occurrence of this disease and the subsequent control practices that are in place in South Africa. Isolate identification is underway, after several unforeseen setbacks.

Greenhouse pot trials were conducted to investigate the effect of drought on charcoal rot incidence and severity in soybean and sunflower crops and subsequent yield reduction. Although the results have not been statistically analysed yet, results from the water stress

trial showed there was no disease incidence for either sunflower or soybeans at seedling stage. Latent colonisation within the stems was found up to 1cm above the root zone even in plants that were not water stressed, suggesting that drought conditions are not required for infection. During flowering, colonisation was measured up to 2cm above root zone for soybean and 3cm for sunflower. No disease was observed in the sunflowers, which could be due to tolerance within the cultivar planted. In soybeans, disease was observed at flowering in both the water stressed and non-water stressed treatments – the latter with lower severity. At harvest disease incidence and severity were high in the inoculated and water stressed soybean and sunflower plants, and stem colonisation was observed 3cm up the stems in all inoculated plants irrespective of water stress. Yields from the water stressed non-inoculated plants as well as the water stressed inoculated plants were half that of the yields from the control plants (non-inoculated and non-water stressed). Plants that were inoculated but not water stressed showed similar yields to that of the control. Another pot trial evaluated the effect of urea and limestone ammonium nitrate (LAN) applied pre-plant at the recommended rate (15kg/ha for soybeans; 50kg/ha for sunflowers) and half the recommended rate on disease development. For soybean, long and medium growth class cultivars were selected and for sunflower medium and medium-late seasonal cultivars were selected. Results have not been statistically analysed yet, however growth, stem width, total nitrogen and number of seeds/pods seemed to be unaffected by the pathogen under the different N applications in different growth habit cultivars. The pathogen colonised soybean and sunflower stems up to 3cm from the root zone throughout all the treatments. No disease was observed and higher yields were recorded in the long growth class soybean cultivar that did not receive nitrogen pre-plant. Higher disease incidence and severity were associated with urea applications in soybeans. In the sunflower trial disease incidence and severity were higher in the medium cultivar than in the medium-late cultivar irrespective of the nitrogen applications. No disease was observed in medium-late cultivar sunflowers treated with LAN at half the recommended rate or urea at the recommended rate.

For the decision support system, historical weather data, literature mining and various calculations were utilised. The optimal growing temperatures of South African *M. phaseolina* isolates were found to be between 25 and 30ºC. Coupled with the reduced rain and constraints on irrigation we would expect higher incidence of this disease than in rainy seasons. There is very little information available on the incidence of charcoal rot

on sunflower or soybeans in terms of location and year of outbreak. However, during the 2011/2012 growing season where losses in maize due to charcoal rot of up to 60% were recorded. For this reason, the decision support system model will be based on maize data, using the 2011/2012 incident to validate the model. From this the model can be adjusted for sunflower and soybean crops.

Future research from this project could be focused on investigating epidemiological aspects of the disease to refine the decision support system for use at farm level. A lay article on this disease and research was published in The Conversation in August 2016 (theconversation.com). Upon completion of the project, results will be published in peer reviewed articles in scientific journals, articles in local media such as Farmers Weekly and Oilseeds Focus, and presented at farmer days.

## 6.3 STUDIES ON *LECANICILLIUM MUSCARIUM* AS A MYCOPARASITE OF THE SOYBEAN RUST FUNGUS, *PHAKOPSORA PACHYRHIZI* AND ITS USE AS A BIOCONTROL AGENT AGAINST SOYBEAN RUST; KS Yobo, University of KwaZulu-Natal

In this study, a Isolate N-08, a mycoparasitic fungus, was isolated from Assagay coffee farm, Cato Ridge, KwaZulu-Natal, South Africa, where it was observed parasitizing *Hemileia vastatrix*, the causal agent of coffee rust. Based on morphological and molecular studies the Isolate N-08 was identified as *Lecanicillium muscarium* and it was deposited into the National collection of fungi (Accession number PPRI 13715).

Co-inoculation studies of *L. muscarium* and *P. pachyrhizi* were done in UKZN Plant Pathology disease garden. The Environmental Scanning Electron Microscope (ESEM) observation of the interactions showed a mycophilic attraction of *L. muscarium* to *P. pachyrhizi* urediniospores. Long *L. muscarium* phialides were observed penetrating and wrapping tightly around *P. pachyrhizi* urediniospores.

*In vitro* studies to test the effect of the *L. muscarium* strain N-08 on *P. pachyrhizi*, the soybean rust fungus, were done. *L. muscarium* strain N-08 was observed colonizing *P. pachyrhizi* under light microscope and ESEM. Laboratory experiments were conducted to assess the effects of different growing conditions (temperatures, artificial growing media, natural substrates and UV radiation) on colony growth and conidia production.

Optimization of growing conditions is one of the essential aspects which must be taken into consideration to produce an effective biocontrol agent. *L. muscarium* strain N-08 grows best at temperatures between 21 to 25$^{o}$C. The highest radial growth was observed at 24$^{o}$C (46.54 mm). V8 juice agar was the best media for colony growth with the mean value of 42.75 mm followed by SDA with 37.86 mm. When the isolates were exposed to UV light, the results did not show a significant difference between different media on mycelia growth. The highest conidia production occurred on millet cereal (4.2 x $10^9$ conidia/ml) followed by wheat bran (3.2 x $10^9$ conidia/ml) and pearled barley (2.9 x $10^9$ conidia/ml).

The optimal dose level for disease control was assessed in the greenhouse and in field trials. It was found that $10^6$ and $10^8$ conidia/ml were more effective and $10^6$ conidia/ml was chosen as the optimum dose for the field application.

Effect of *L. muscarium* against soybean rust was evaluated in the field. Two field experimental trials (2014/2015 and 2015/2016) were run at Ukulinga Research Farm. Compared to the pathogen inoculated control, all the three *L*. *muscarium* doses ($10^4$, $10^6$, $10^8$ conidia/ml) and the fungicide control (Score) decreased disease severity by 73.3%, 88.2%, 89.1%, and 90% respectively. The Area Under the Disease Progress Curve (AUDPC) for the treatments were as follows: 1$^{st}$ trial, Score (172.2 units), $10^8$ conidia/ml (186.2 units), $10^6$ conidia/ml (202.16 units), $10^4$ (457.8 units) and pathogen inoculated control (1716.8 units). 2$^{nd}$ trial, score (259.7 units), $10^8$(284.9 units), $10^6$ (319.9 units), $10^4$ (462.7 units) and the pathogen inoculated control (1053.5 units). Treated plots showed higher yield increase compared to the pathogen inoculated pathogen. However, dry seed weight did not significantly differ between the *L*. *muscarium* strain N-08 treated and score fungicide treated plots.

## 6.4 CHEMICAL MANIPULATION OF VEGETATIVE GROWTH, REPRODUCTIVE DEVELOPMENT AND GRAIN YIELD IN CANOLA; GA Agenbag, University of Stellenbosch

Canola (*Brassica napus* L.) is one of the most important sources of plant oil in the world and is rapidly becoming an important crop in the South Africa as well. Although yield per hectare increases during recent years due to the introduction of hybrid cultivars and

improved production techniques, yield per hectare is still low compared to leading world producers such as Canada.

Lower than expected yields may be the result of several factors such as low and uneven plant populations, insect pests, poor plant nutrition management and weed control as well as harvesting losses. The highest yields in South Africa are achieved with early plantings on high fertility sites, but this practice often produce bulky crops, which when combined with high plant populations may result in lodging during pod development.

Research done in Australia, showed that shorter plants are much more resistant to lodging than taller plants. By shortening the stem and changing the canopy structure with the use of plant growth regulators (PGR's), an even, compact pod canopy can be produced. As a result, competition for assimilates and light can be reduced, ripening will be more uniform, pod shattering will be reduced and harvesting will be more efficient.

No PGR's are at present registered for use in canola, in the RSA, but preliminary research done recently with the PGR's, Primo Maxx® and Moddus® as well as liquid seaweed extract (Kelpak®) showed promising results in both pot and field trails. For this reason field trials were conducted during 2015 and 2016 at 3 localities in the Swartland (2) and Southern Cape (1) canola producing areas. Three spraying treatments (control, Kelpak®and Moddus®) in combination with different application rates and two different plant densities were tested.

In contrast to 2015 when generally poor growing conditions due to low rainfalls were experienced at all localities but large responses with treatments were noted, applications of Kelpak® and Moddus®) at budding stage did not increase grain grain at any locality in either low or high plant population plots during 2016 when generally favorable growing conditions prevail at all localities. However, when applied at both budding stage and at the onset of flowering, increases in grain yield were reported at Altona and Langgewens with applications of 4.0 L of Kelpak® per hectare, while Moddus®) did increase grain yield by up to 380 kg per hectare at Langgewens when applied at a rate of 0.4 or 0.8 L per hectare. Similar but smaller yield increases with the application of Moddus®) were also recorded at Roodebloem. These results indicated that both Kelpak® and Moddus®) showed better results when growing conditions were not optimal.

## 6.5 NITROGEN TOPDRESSINGS IN CANOLA; TIME OF APPLICATION AND RATES; GA Agenbag, University of Stellenbosch

Previous research projects in the Western Cape showed that application rates of 80-120 kg of N $ha^{-1}$ and 15-30 kg S $ha^{-1}$ are needed to produce canola grain yields of more than 2.0 ton $ha^{-1}$ in soil with low organic C contents. These high fertiliser requirements increases production costs and often make nitrogen and sulphur fertilisation the most costly production factor in canola.

The efficiency of applications is affected by soil properties and climatic conditions and very importantly by time of application. Research done in Canada showed that although the nitrogen uptake by canola is the highest from the 5-leaf to 50% flower (which in the Western Cape is reached at 80-90 days after planting), uptake remain high till 50% podded stage (120-130.days after planting). These results indicated that nitrogen topdressing the flowering stage of canola may be important in high yielding canola crops.

In order to determine optimum nitrogen application strategies for different soil and climatic conditions, field trials were conducted during 2015 and 2016 at 3 localities in the Swartland (2) and Southern Cape (1) canola producing areas. Four nitrogen rates namely 60, 90, 120 and 150 kg N $ha^{-1}$ were tested, with 20 kg N $ha^{-1}$ applied at planting and the remaining nitrogen applied as a single top dressing at 30 days after planting (dap); divided between 30 and 60 dap or divided between 30, 60 and 90 dap (full flowering stage). Control plots did not receive any nitrogen fertiliser.

In contrast to 2015, most canola producing areas in the Western Cape experienced rainfall during the 2016 growing season which were close to the long term means. These conditions together with generally low maximum temperatures during September resulted in high canola grain yields. Mean yields in trails varied between 1681 kg $ha^{-1}$ at Langgewens (low rainfall locality) to 3300 kg $ha^{-1}$ at the high rainfall locality of Altona. In the Southern Cape (Roodebloem locality) a mean yield of 1877 kg $ha^{-1}$ was recorded.

At the high rainfall locality of Altona, the highest yield of 3420 kg $ha^{-1}$ was obtained with a nitrogen application of 120 kg $ha^{-1}$ of which 20 kg N $ha^{-1}$ was applied at planting and the rest (100 kg N $ha^{-1}$) divided between 30 and 60 days after planting.

At Roodebloem, the highest yield of 2228 kg $ha^{-1}$ was also obtained with 120 kg N $ha^{-1}$, but at this locality it was achieved with only one topdressing at 30 days after planting. At Langgewens (low rainfall locality), the highest grain yield of 1779 kg $ha^{-1}$ was obtained with only 90 kg N $ha^{-1}$, but with topdressings at 30, 60 and 90 days after planting

Results shown that the optimal application rate and time of application differs between localities and most probably also between years. For this reason it will be necessary to develop criteria to enable producers to decide on the best application strategy in different growing seasons.

## 6.6 GRAIN YIELD COMPETITION FOR CANOLA 2016; GA Agenbag, University of Stellenbosch

The PRF Canola Grain Yield Competition was held during 2016 for the second year and tough competition and high grain yields were experienced amongst competitors.

In the Swartland production area, the 14 competing producers showed on average a grain yield of 2.03 ton per hectare on a total area of 459 hectares. In the Southern Cape a mean grain yield of 2.34 ton per hectare was recorded on a total area of 272 hectare and 8 out of the 11 competing producers recorded yields of more than 2.0 ton per hectare.

Mr Dirk Lesch (Elim Boerdery near Malmesbury) won the Swartland competition, while Mr Pieter Beukes (Yahshua Boerdery near Caledon) won the competition in the Southern Cape.

Mr Lesch recorded a grain yield of 2.66 ton per hectare from a canola field of 18.7 hectare, planted on 26 April 2016 with the DuPont-Pioneer canola-cultivar 45Y88 at a planting density of 2 kg seed per hectare. Mr Beukes also used the DuPont-Pioneer canola-cultivar 45Y88. His canola field of 15.7 hectare was planted on 27 April 2017 at a density of 4 kg seed per hectare and he recorded a record winning grain yield of 3.09 ton per hectare.

## 6.7 CANOLA TECHNOLOGY TRANSFER; GA Agenbag, University of Stellenbosch

The timely transfer of technology and information on the production of canola are very important to ensure that producers are optimizing their production techniques to obtain

maximum yields. For this reason canola-information days are organized annually by the PRF. During 2016 the third annual canola-information day was held for agricultural advisors of the Agro-chemical industry.

The program for the day included a range of production related subjects, but special attention was given to the control of diseases such as Sclerotinia. There can be little doubt that information presented during this day contributed to the highly successful control of this disease during 2016 and more optimal production techniques used by producers which ensured that several producers obtained grain yield of more than 2 ton per hectare.

## 6.8 AN EVALUATION OF CONTINUOUS CASH CROP PRODUCTION (INCLUDING SMALL GRAINS, CANOLA AND OTHER ALTERNATIVE BROADLEAF CROPS) UNDER CONSERVATION AGRICULTURE PRINCIPLES ON HIGH POTENTIAL SOILS OF THE RIVERSDALE FLATS; JA Strauss, Western Cape Department of Agriculture

2016 was the 5$^{th}$ year of continuous cropping research at the Riversdale site. Six cash crop systems are tested including shortened canola rotations and cover crops. A total of 60 plots are planted. The 6 systems tested are replicated 3 times and all crops within each system are represented on the field each year.

Riversdale received excellent summer rainfall of just over 200mm in the pre-season which resulted in enough available moisture to plant at the end of April. Unfortunately there were issues with the rainfall data generated by the ARC weather stations and we could not get an accurate description of the rainfall though out the production season. General indication was that the rain during the 2016 production season was less than average. The Western Cape Department of Agriculture has invested in our own weather stations at all the main crop rotation trial sites.

Hyola 555 was planted at Riversdale at 3.9 kg/ha. A total of 45 kg N/ha was applied to each plot (24kg N/ha at planting and 21kg N/ha top-dressing). Canola plots following the legume cover crop did not receive the topdressing. Canola yields at Riversdale averaged 2275 kg/ha with all plots showing oil yield above 43%. Canola yields ranged from 1324 kg/ha to 2833 kg/ha. This was on average 855 kg/ha more than the 2015 season (1420 kg/ha) and 845 kg/ha more than the 2014 season (1430 kg/ha). The canola following the

legume cover crop in the system cover crop – canola – wheat has outperformed the canola in other systems every year since the inception of the new rotation systems at the Riversdale site, even when other plots received an extra topdressing.

## 6.9 INVESTIGATING THE POTENTIAL OF INDIGENOUS NEMATODE TO CONTROL INVASIVE MOLLUSCS IN CANOLA; A Pieterse, JL Ross and AP Malan, University of Stellenbosch

European molluscs (slugs and snails) have become significant pests in South Africa, especially in terms of targeting canola crops in the winter months. The local production of canola is an important objective for the Protein Research Foundation, as it is the only successful method for the large-scale production of animal feed protein in the Western Cape Province. Therefore, protecting this crop is important. Current methods for controlling molluscs, which rely on synthetic chemical pesticides, are often overused, ineffective and toxic to non-target organisms and the environment. Therefore, identifying a biological remedy is of key importance. The use of mollusc-parasitic nematodes is a feasible environmentally friendly alternative.

As of current knowledge, eight nematode families associate with molluscs, including Agfidae, Alaninematidae, Alloionematidae, Angiostomatidae, Cosmocercidae, Diplogastridae, Mermithidae, and Rhabditidae. To date, *Phasmarhabditis hermaphrodita* is the only nematode to have been developed as a biological molluscicide in Europe. The nematode, which was commercially released in 1994 by MicroBio Ltd, Littlehampton, UK (formally Becker Underwood, now BASF) under the trade name Nemaslug®, is now sold in fifteen different European countries. Due to current legislation, Nemaslug® can neither be sold, nor used in South Africa. A survey was, therefore, conducted in the Western Cape Province of South Africa to locate local nematode isolates capable of causing mortality in invasive mollusc pests.

A total of 1944 slugs were collected from 12 different study sites. On the identification of the slugs, they were dissected alive, and examined for internal nematodes. The nematodes were identified using morphological and molecular techniques (18S rRNA). Seven of the 12 sites had nematodes present, with 8% of the slugs being found to be infected with nematodes. Six nematode species were identified, including *Angiostoma margaretae*, *Angiostoma* sp. SA1, *Caenorhabditis elegans*, mermitid sp. SA1,

*Phasmarhabditis* sp. SA3, and *Phasmarhabditis papillosa* (previously referred to as *Phasmarhabditis* sp. SA4). Of the six species mentioned, four were previously undescribed. The isolation of new *Phasmarhabditis* spp. indicates the importance of conducting further surveys of mollusc-parasitic nematodes in South Africa.

Nematodes isolated in the survey were tested for their ability to reproduce on decaying organic matter, with results demonstrating that one of the nematodes, *P. papillosa*, could complete its life cycle under such conditions. *Phasmarhabditis papillosa* was, then, fully described and characterised by the shape and length of the female tail, and by the presence of males. Phylogenetic analysis demonstrated that *P. papillosa* was placed in a monophyletic clade, along with *Phasmarhabditis* sp. SA2 (another isolate found in South Africa), *P. papillosa* (US strain), and the mollusc-parasitic nematode, *Angiostoma dentiferum*.

*Phasmarhabditis papillosa* was established in monoxenic cultures. Five bacterial isolates were isolated from the intestine of slug hosts, identified using 16S rRNA gene sequences, and their pathogenicity tested by means of injecting directly into the haemocoel of *D. reticulatum*, and monitoring the mortality over time. *Kluyvera* sp., which was found to cause the highest mortality rate among the slugs concerned, was chosen for monoxenic culturing. Cultures containing *P. papillosa* and *Kluyvera* sp. were optimised using temperatures ranging from 15°C to 25°C, with results showing that the former was the optimum growth temperature.

The results of this project have been presented at both national and international levels. The local integrated pest management meetings, held at Stellenbosch University, act as a link between research and industry, and have proved to be a successful method for transferring knowledge to end users. In addition, outputs of this project have also been presented at Stellenbosch University's annual research day, with the PRF-funded student involved winning a prize for best presentation. Furthermore, the student also won a prize for best presentation at the 21st Nematological Society of Southern Africa conference, held in Durban in May 2017. The student's presentation of a summary of her MSc project elicited significant interest from both researchers and industry. Furthermore, the self-same student, since graduating in 2016 *cum laude*, has acquired funding from the CSIR/NRF to continue this project for her PhD.

The outputs of this project have been published in peer review journals. Three papers have been accepted thus far, with another currently being under review. Furthermore, two popular articles have been published, one in the African Fruit Journal, and another in the Scottish Farmer.

Now that a local nematode isolate has been identified and cultured with a highly pathogenic bacterial species, the next phase of the work is to optimise production systems, and to develop a suitable formulation method. Further pathogenicity tests are also required to determine the nematode's host range, and effect on non-target organisms. The final phase of this project is to develop an in-depth business plan for the proposed product, so as to enable applications to be made for future funding from government seed funding, and to attract future venture capital / angel investors to assist with the final commercialisation scale-up phase, following the finalising of the project.

## 6.10 DEVELOPMENT AND EVALUATION OF PROTEIN AND PHOSPHOROUS FEED INGREDIENTS FROM FISH PROCESSING BY-PRODUCTS; N Goosen, University of Stellenbosch

The research in this project aimed to develop technology to transform low value fish by-products into higher value and high quality protein and phosphorous animal feed ingredients, and to evaluate the performance of these ingredients in animal feeding studies. Optimal utilisation of limited marine resources is of global importance from economic and sustainability perspectives, and a country such as South Africa which has rich fisheries resources, can benefit from further unlocking the economic potential from its natural fish stocks.

During the course of the project, successfully optimized processing techniques were developed to recover hydrolysed proteins and bone minerals from typical South African fish processing by-products. The hydrolysed proteins and bone minerals were then evaluated as dietary sources of protein and phosphates respectively, using the African catfish (*Clarias gariepinus*) as model species. All experimental investigations for the entire project have been completed and the final laboratory and statistical analyses are being performed to characterize bioavailability of the novel feed ingredients, and their ability to sustain good production performance and animal health.

Results from the study have been encouraging, to say the least. Apart from the original aims, the research has also managed to produce a high-value phosphate mineral which is used in medical applications, and investigations into recovery of gelatine from the bones have been initiated. Discussions are currently under way with a potential industry partner to design a piloting facility and complete market studies on the hydrolysed protein and phosphate products. Further acknowledgement of the value and quality of the work was realised through acceptance of two conference proceedings, one to be delivered at the World Aquaculture Society Conference in Cape Town in June 2017, and the other at the Aquaculture Europe Conference in Dubrovnik, Croatia in October 2017. At both of these conferences, the nutritional aspects of the newly-developed ingredients will be presented to an international audience, and it is the belief that the conference papers will be reworked into full scientific journal articles. By the end of 2017 a total of 3 postgraduate students would have graduated through the research completed as part of this project.

## 6.11 MANAGEMENT STRATEGIES FOR SOYBEAN SOILBORNE DISEASES IN SOUTH AFRICA; YT Tewoldemedhin and SC Lamprecht, ARC Research Institute for Plant Protection

Seed treatment is a very important part of integrated management strategies against soilborne diseases of field crops. Surveys conducted in the major soybean production areas during 2010/11, 2011/12 and 2013/13 showed that many important soilborne pathogens are present in soybeans in South Africa. Many of these pathogens such as species within *Fusarium*, *Pythium* and *Rhizoctonia* affect seedling survival and establishment of soybean crops. In order to protect seedlings against these pathogens, glasshouse trials were conducted during 2014/15 and 2015/16 to evaluate fungicide seed treatments against damping-off and root rot caused by the most important soilborne pathogens. Three of the most effective treatments were selected for evaluation under field conditions. The current study therefore included the evaluation of the seed treatments Evergol (TR1), Celest XL+Apron XL (TR2), Maxim Quatro (TR3) and untreated seed (TR4) on three soybean cultivars viz DM 6.8i.RR, PAN 1454R and SSS 5052 in the cool (Bethlehem), moderate (Potchefstroom) and warm (Groblersdal) production areas. The field trials at Groblersdal and Potchefstroom were irrigated and the trial at Bethlehem was planted under dryland conditions. Soil was also collected from the trials to conduct similar tests under glasshouse

conditions to evaluate the seed treatments on the three cultivars. The survival of seedlings at Bethlehem was significantly higher for treatments with Evergol and Celest XL+ Apron XL than for untreated seed. The same trend was recorded at Groblersdal and Potchefstroom although there were no significant differences in survival of seedlings from the different seed treatments at these localities. In non-pasteurised soil from Bethlehem under glasshouse conditions, all three treatments significantly improved survival of seedlings with TR1 and TR2 treatments resulting in the highest survival rates and in Groblersdal soil TR1 and TR2 also significantly improved survival, but in soil collected from Potchefstroom TR2 was significantly more effective than TR1 and TR3 to improve survival. Although the survival of seedlings was highest six weeks after planting at Bethlehem and Groblersdal for DM 6.8iRR and PAN 1454R, the yields were highest at Bethlehem and Potchefstroom. Unfortunately heavy rain and bird damage at Groblersdal resulted in very low yields in the field trial. It therefore appears that survival of seedlings is not always correlated with yield under field conditions and that other factors also affect yield. At Potchefstroom treatment of seed of cultivar DM 6.8iRR with Evergol (TR1) increased yield with 4.5% and treatment with Celest XL + Apron XL (TR2) increased yield with 17.8%. However, for cultivar PAN 1454R treatment TR1 increased grain yield with 34.5% and TR2 with 13.3%.

Overall increases in yield of the two cultivars combined at Bethlehem showed an 18.4% increase for TR1 and 6.3% increase for TR3 at Bethlehem and a 16.6% increase for TR1 and a 16.0% increase for TR2 at Potchefstroom compared to the untreated seed treatment (TR4) control. Although these increases were not statistically significant, it is biologically significant and shows the huge impact that seed treatments can have on yield, but also that the same seed treatment can have a different effect on different cultivars. Survival of SSS 5052 seedlings was significantly lower than the survival of seedlings of the other two cultivars at all the localities and it was interesting to note that the yield of cultivar SSS 5052 at Potchefstroom was significantly higher for the untreated seed than seed treated with the three fungicides. This confirms the suspicion that this cultivar was unfortunately double treated and that this caused the plots from the treated seed to have such a poor performance. Treatment of seed with Evergol (TR1) significantly reduced growth of seedlings under glasshouse conditions, especially on seedlings younger than two weeks old. However, despite the growth reduction in young seedlings, this seed treatment proved to be very effective in improving survival of seedlings and grain yield and also appears to be more effective for the control of *Fusarium* species that are pathogens of soybean seedlings

than Celest XL + Apron XL. Soil pasteurisation and seed treatments TR1, TR2 and TR3 significantly reduced cotyledon and root rot severity for all three cultivars under glasshouse conditions. Treated seed plated to determine the effect of seed treatments on the incidence of seedborne fungi showed that, of the eight potential pathogens isolated from untreated seed, *F. equiseti* and *P. longicolla* could still be isolated from TR1 treated seed, *B. maydis*, *F. equiseti*, *F. temperatum*, *F. verticillioides*, *Phomopsis* sp. and *P. longicolla* from TR2 treated seed, and *F. equiseti* and *P. longicolla* from TR3 treated seed. Surface disinfestation eliminated many of the seedborne fungi, however, *F. equiseti* and *P. longicolla* could still be isolated from surface disinfested seed. It is also important to note that fungi that were seedborne such as *F. verticillioides* and *P. longicolla* were significantly more often isolated from seedlings planted in pasteurised compared to non-pasteurised soil which demonstrates the transmission of these pathogens from seed to seedlings. The glasshouse test conducted to determine the effect of potential pathogenic fungi isolated from seed and seedlings from treated seed in field soil showed that the fungi that significantly reduced survival were *F. andiyazi*, *F. cerealis*, *F. oxysporum*, *P. longicolla* and all the *Pythium* spp. Seed treatments TR1 and TR2 significantly increased survival of seedlings in soil inoculated with *F. andiyazi* and although seed treatment TR3 also significantly increased survival, it was less effective. Seed treatment TR2 was also less effective compared to TR1 and TR3 to increase survival in soil inoculated with *F. oxysporum*. For *P. longicolla* and all the *Pythium* spp. all three seed treatments TR1, TR2 and TR3 effectively controlled damping-off. In the present study none of the *Rhizoctonia* isolates obtained caused significant damping-off. Fungicide seed treatment is a common practice for managing soilborne, seed, and seedling pathogens. Evaluating seed treatments for control of soilborne diseases under glasshouse conditions allows the evaluation of single pathogens which is important to determine the efficacy against some of the most important soilborne pathogens. However, since these products are ultimately intended for management of soilborne pathogens under field conditions it is essential to evaluate seed treatments under field conditions. It is well-known that there is a complex of soilborne pathogens that affect soybean in field soil and that these complexes differ in different production areas and are affected by different soils and climatic conditions. From this report it is also clear that there were cultivar by seed treatment interactions indicating that certain treatments may be more beneficial to certain cultivars than others and certain seed treatments are better suited to certain production areas than others. The challenge is to identify a seed treatment that will benefit establishment and yield of most cultivars in most production areas under both dryland and irrigation systems.

During the 2017/18 season the three seed treatments will be evaluated again on three soybean cultivars in the cool, moderate and warm production areas, to confirm results that seed treatment has the potential to increase seedling survival and grain yield of soybean in South Africa.

## 6.12 PERFORMANCE OF A DUAL DISCH AND TINE PLANTER, SOIL QUALITY, RESIDUE MANAGEMENT AND RATE OF NITROGEN PLACEMENT WITH SEED FOR CANOLA PRODUCTION; PA Swanepoel, PJG le Roux and GA Agenbag, University of Stellenbosch

Canola is produced in the Western Cape of South Africa under Mediterranean climate conditions. Although farmers have widely adopted conservation agriculture (CA) in this area, the residue of the previous crop retained as cover becomes problematic during establishment. Stubble obstructs tine openers and farmers have started to consider disc seeders. Theoretically, disc seeders can cut through residue. The aim of this study was to compare establishment of canola with a tine and disc opener through residue on soils of high and low quality. Trials were conducted at Langgewens Research Farm (33.2765 S 18.7048 E) where CA have been implemented for the past 20 years. Three factors were assessed in a split-plot design, i.e. soil quality (high and low as whole plots), opener (tine or disc as split-plots) and residue level (low, medium and high, nestled within split-plots), replicated in four blocks. Soil quality was determined using the Soil Management Assessment Framework and Solvita soil health tests. Following planting on 25 May 2016, soil micro relief was measured. Soil disturbance, plant population density, biomass production and yield were assessed. The tine opener disturbed soil more ($p<0.05$) than the disc. There was a higher ($p<0.05$) plant population density for the tine planter at all three residue levels, which indicates more effective establishment. Canola established with the disc seeder compensated well to the end of the growing season, thus the difference ($p<0.05$) in biomass production at 30 days after planting between the tine and disc seeder were eliminated at physiological maturity ($p>0.05$). No difference ($p>0.05$) in yield was observed between any of the three factors. The trial will be repeated for three years before solid conclusions could be drawn.

## 6.13 PROJECTED PROTEIN REQUIREMENTS FOR ANIMAL CONSUMPTION IN SOUTH AFRICA; D Strydom and W de Jager, University of the Free State, E Briedenhann, Protein Research Foundation

The growth in the domestic availability of oilcake is a good measure by which the PRF could ascertain if it was achieving its objectives, by way of supporting the industry with research, new technology and technology transfer. The targets that will need to be met in the future for the PRF to continue to emulate the great progress that has been made thus requires projections of future oilcake demands and what will be required to obtain self-sufficiency, as well as when this goal is likely to be met. The APR model in collaboration with BFAP data is used to calculate these projections.

**Table 1: Historical usages of oilcake (Local and imported soybeans processed in South Africa)**

| Year | Local Soya (ton) | Total Oilcake (ton) | Local % |
|---|---|---|---|
| **2008/09** | 565 181 | 1 664 916 | 33,9 |
| **2009/10** | 701 030 | 1 743 137 | 40,2 |
| **2010/11** | 624 912 | 1 857 391 | 41,3 |
| **2011/12** | 766 927 | 1 856 360 | 41,3 |
| **2012/13** | 760 321 | 1 877 671 | 40,5 |
| **2013/14** | 913 356 | 1 889 979 | 48,3 |
| **2014/15** | 1 197 604 | 1 914 330 | 62,6 |
| **2015/16** | 1 238 120 | 1 965 291 | 63,0 |

**Table 2: Local vs imported soya oilcake**

| | Local Soya Oilcake (From local soybeans) ton | Local Soybean Production (required) ton | Total Soya Oilcake Requirements ton | % Local |
|---|---|---|---|---|
| **2015** | 563 578 | 741 550 | 1 324 436 | 42,6 |
| **2020** | 1 216 000 | 1 600 000 | 1 537 927 | 79,1 |
| **2025** | 1 596 000 | 2 099 000 | 2 112 764 | 75,5 |

According to the model feed requirements will increase to 14 624 422 tons in 2025 and 12 767 149 tons in 2020 from 11 736 738 tons. Oilcake requirements will increase from

1 965 291 tons to 2 074 931 in 2020 and 2 561 503 tons in 2025. Soya oilcake requirement will be 1 537 927 tons by the year 2020 and 2 112 764 by 2025.

The poultry sector plays a major role in oilcake and particularly soya oilcake usage. Growth and sustainability in the poultry industry will play a major role in oilcake requirements.

For South Africa to achieve 79% of soya oilcake requirement self-sufficiency by 2020 the country will need to produce 1, 6 million tons of soybeans, to achieve 76% by 2025 the country will need to produce 2,1 million tons of soybeans.

## 6.14 INCOME AND COST ESTIMATES OF SOYBEANS AND CANOLA AND A FEW COMPETITIVE CROPS; SG Ferreira, Protein Research Foundation and Agriconcept

The 2015/16 research report included a complete description of the composition and functions of income and cost estimates. However, Mr SG Ferreira of Agriconcep indicated that he can no longer do the income and cost estimates due to increased work pressure. The PRF approached Grain SA and BFAP in an attempt to avoid duplication, but also to maintain the same format that all got used to over so many years. The next research report will contain more detailed information about the new approach and will highlight any changes that may become necessary.

The PRF is very grateful toward Mr Ferreira for all the years of handling this very important project on behalf of the PRF.

## 6.15 PRF WEBSITE; M du Preez and Y Papadimitropoulos, Protein Research Foundation and Tigme.com

The PRF was proud to announce its new web site going live on 1 December 2016. The outlay is more visual and colourful, with large banner photos at the top of each page, advertising new publications and interesting news on the site.

**Home Page Contents**

The Protein Research Foundation’s new site consists of a phenomenal total of more than 800 pages, growing monthly as new information is being added. The total includes the dynamic pages such as the research database index ("Research Database"). These form other dynamic pages programmatically when following an index heading.

Another focal point was to expand the section containing the photo gallery and videos published on YouTube.

**Home Page Structure**

With the development of the PRF’s new web site, it was upgraded to HTML5 in combination with the existing HTML4. The objective of this combination was HTML5, because it is not being implemented fully by all web browsers and search engines yet, despite being applied increasingly with each new software upgrade.

The link structure was also adjusted to be accessed faster. Most of the information on the web site contains a lot of in-depth flowing sub-sections. In the past an information page was uploaded, allowing links to be followed as the visitor delved deeper to find information. Now the visitor may delve using the links. The page information is loaded only once the required link is reached.

**Search Engine Visibility**

In April 2016, Google implemented its algorithm to give preference to web sites that were "mobile ready" or "mobile first". This was one of the driving forces to upgrade the Protein Research Foundation’s web site. Each page was tested for mobile adaptability. This included complicated data tables.

Another important requirement of search engines, although not officially implemented yet, was to require any web site that collects information from members of the public using online forms, to install SSL certificates. Previously this was required only from sites that conducted online sales.

The easiest place to see whether a security certificate is in place when using a site, is to compare the web address protocol:

http:// No security certificate and encryption installed
https:// SSL ("Secure Sockets Layer") security certificate with encryption installed

The PRF web site uses online application and subscription forms and as such the security and encryption certificates had been installed on the PRF domain.

The implementation of the Protein Research Foundation's new web site also involved a refined SEO ("Search Engine Optimisation") according to the latest known search engine algorithms. These include, inter alia, better defined file names for photos, diagrams and figures, programmatic photo descriptions (not visible to general web site visitors) and built-in meta photo identification and definitions ("embedded meta data").

**Visitor Statistics**

One of the measurements to determine user value of the web site is to determine the number of visitors and time spent on the sites, including number of pages visited. The statistics below indicate the number of visitors per reporting year since inception of the web site.

| **Reporting Year** | **Unique Visitors** *Raw values** | **Unique Visitors** *Google values* | | |
|---|---|---|---|---|
| | | *Visitors* | *Pages* | *Pages per visit* |
| 2004 | 1 691 | | | |
| 2005 | 3 285 | | | |
| 2006 | 4 552 | | | |
| 2007 | 5 404 | 3 041 | 10 838 | 2.79 |
| 2008 | 11 104 | 5 274 | 18 829 | 2.82 |
| 2009 | 10 194 | 6 610 | 27 341 | 3.18 |
| 2010 | 11 812 | 6 054 | 23 347 | 2.98 |
| 2011 | 12 357 | 5 511 | 24 258 | 3.29 |
| 2012 | 16 306 | 6 909 | 28 206 | 3.12 |
| 2013 | 54 739 | 8 767 | 34 284 | 2.97 |
| 2014 | 54 590 | 10 189 | 39 363 | 3.03 |
| 2015 | 35 653 | 12 519 | 45 078 | 3.60 |
| **2016** | **31 674** | **8 733** | **53 811** | **4.47** |

* *Raw values indicate the total interactions as measured by the web server while Google values only indicate the visitors that link using a web browser. Visitors linking to the web site are not counted again when they link using the same web browser.*

## 7. STUDY GRANTS AND BURSARIES

The PRF bursary scheme was approved in 1994 and the first study bursary for postgraduate studies was awarded for the 1995 academic year. We are proud to look at a period of 22 years that included a total of 72 bursaries awarded to deserving candidates for Masters' and Doctorate studies. The aim of the bursary scheme is to train deserving candidates to allow them to contribute to high quality scientific research after completing their studies. This includes, in particular, research aimed at promoting the production of protein for animal consumption.

Students are also encouraged to publish, in co-operation with their mentors, the research results. This includes publication in scientific journals and/or popular magazines. Management summaries of theses and manuscripts are also published on the PRF web site and data base.

Bursaries for Masters' studies are awarded for a period of two study years and three years in case of Doctorate studies. Bursaries awarded for this year were approved by the Bursary Committee (a sub-committee of the Marketing Committee) and were as follows:

### 7.1 MSc Studies

7.1.1 **Mr W de Jager** (Second application). "An integrated model to project animal protein consumption in South Africa", University of the Free State.

7.1.2 **Ms KZ Neethling** (Second application). "Die effek van verskillende kombinasies van proteïen en energie bronne op veselvertering van ruvoere", Stellenbosch University.

7.1.3 **Ms JA Engelbrecht** (Second application). "The evaluation of alternative protein sources (lupins, canola and canola oilcake in ostrich nutrition)", Stellenbosch University

7.1.4 **Mr A Coetzee** (Second application). “Stikstof bo-bemesting op canola: Tyd en toedieningstempo’s”, Stellenbosch University

7.1.5 **Mr PJG Le Roux** (First application). “Die evaluasie van tand- en skyf-oopmakers om canola te vestig op grond met verskillende fisiese, chemiese en biologiese toestande (grondkwaliteit)”, Stellenbosch University

7.2 PhD Studies

7.2.1 **Ms M du Plessis** (Third application). “Molecular markers for drought tolerance in soybean”, University of Pretoria.

7.2.2 **Ms E Jordaan** (Third application). “Epidemiology and population structure of *Macrophomina phaseolina* (Charcoal rot) on sunflower and soybean” University of Pretoria.

7.2.3 **Ms L van Emmenes** (Second application). “The use of fly larvae meal as an alternative protein source in the diets of monogastric animals, farmer, consumer and environment”, Stellenbosch University.

7.3 Completed theses received

During the year under review, the following theses were received from bursary recipients that completed their studies successfully.

7.3.1 **Mr W De Jager**, “Forecast estimates of protein for animals in South Africa”. MSc, University of the Free State.

## 8. ACHIEVEMENT AWARDS TO PROMOTE THE PRF VISION AND MISSION

Each year the PRF also recognises individuals for their special contributions to support the PRF’s vision and mission, as well as attaining its objectives.

Awards are categorised as follows:

- Best doctoral thesis;
- Best Master's thesis;
- Best article published in a scientific journal;
- Person who have made an exceptional contribution in promoting the PRF vision and mission;
- A Board Member that contributed significantly to promote the PRF's activities over a period of time;
- An organisation/individual that played an exceptional role in assisting the PRF to achieve its objectives.

During the year under review, the following persons received awards in three of the categories:

1. Best Master's thesis:

    - Ms Anika Pieterse, Stellenbosch University

2. Best article published in a scientific journal:

    - Dr SC Lamprecht, ARC-NIPB

3. Person who have made an exceptional contribution in promoting the PRF vision and mission:

    - Dr J Dreyer, PRF Contractor

    The awards were presented at appropriate events during the year under review.

## 9. CONCLUSION

The PRF presents this research report with much gratitude. The results achieved fall within the requirements and objectives that the PRF set. A large number of institutions and individuals deserve recognition in this process.

We are particularly blessed to have so many co-workers and supporters that are willing to work hard in achieving the PRF's objectives. We honour all the researchers, research institutions, universities and tertiary institutions, but particularly the Department of Agriculture, Forestry and Fisheries (DAFF) and specifically the Harvest Estimates Committee, provincial departments and other supporting services such as the press and all agents that assist us with the transfer of technology. These include producer bodies such as Agri SA, Grain South Africa, SAGIS, SA Grain Laboratory, the commodity trusts (especially the Oil and Protein Seeds Development Trust), co-operations and agricultural companies, seed, chemical and equipment companies and distributers, our auditors, lawyers, bankers, web masters (Tigme.com, Infoworks, XL Millenium), the fund managers (FOORD and Old Mutual) and all those that I do not mention by name, but that are always willing to help.

Our loyal and extremely dedicated staff contributes a lot. It is difficult to find the right words to thank them for all the input during the past year, but also all the years before.

The PRF policy remains to appoint Board Members with particular knowledge that will promote the PRF's activities. All the Board Members that serve as members of the Board contributed to the success of the year. We are truly, honestly grateful.

An unqualified "thank you" to each and every one.

**GERHARD JH SCHOLTEMEIJER**
**CHAIRPERSON**

## ANNEXURES

### I LIST OF APPROVED PROJECTS IN 2016/17

| | | |
|---|---|---|
| 1. | Evaluation of PRF soybean elite lines under South African conditions<br>GP De Beer and WF van Wyk | Protein Research Foundation |
| 2. | Etiology and population structure of *Macrophomina phaseolina* (charcoal rot) in sunflower and soybeans in South Africa<br>E Jordaan and JE van der Waals | University of Pretoria |
| 3. | Studies on *Lecanicillium muscarium* as a microparasite of the soybean rust fungus, *Phakopsora pachyrhizi* and its use as a biocontrol agent against soybean rust<br>KS Yobo | University of KwaZulu-Natal |
| 4. | Chemical manipulation of vegetative growth, reproductive development and grain yield in canola<br>GA Agenbag | University of Stellenbosch |
| 5. | Nitrogen topdressings in canola: time of application and rates<br>GA Agenbag | University of Stellenbosch |
| 6. | Grain Yield competition for canola 2016<br>GA Agenbag | University of Stellenbosch |
| 7. | Canola Technology transfer<br>GA Agenbag | University of Stellenbosch |

| | | |
|---|---|---|
| 8. | An evaluation of continuous cash crop production (including small grains, canola and other alternative broadleaf crops) under conservation agriculture principles on high potential soils of the Riversdale flats<br>JA Strauss | Department of Agriculture: Western Cape |
| 9. | Investigating the potential of indigenous nematode to control invasive molluscs in canola<br>A Pieterse, JL Ross and AP Malan | University of Stellenbosch |
| 10. | Development and evaluation of protein and phosphorous feed ingredients from fish processing by-products<br>N Goosen | University of Stellenbosch |
| 11. | Management strategies for soilborne soybean diseases in South Africa<br>YT Tewoldemedhin and SC Lamprecht | ARC Research Institute for Plant Protection |
| 12. | Performance of a dual disch and tine planter, soil quality, residue management and rate of nitrogen placement with seed for canola production<br>PA Swanepoel, PJG le Roux and GA Agenbag | University of Stellenbosch |
| 13. | Projected protein requirements for animal consumption in South Africa<br>D Strydom, W de Jager and E Briedenhann | University of the Free State and Protein Research Foundation |
| 14. | Income and cost estimates for soybeans and canola and a few competitive crops<br>SG Ferreira | Protein Research Foundation and Agriconcept |

| | | |
|---|---|---|
| 15. | PRF Web Site<br>GJH Scholtemeijer, M du Preez and<br>Y Papadimitropoulos | Protein Research Foundation |

## II LIST OF PROJECTS FINALISED DURING 2015/2016

| | | |
|---|---|---|
| 1. | National soybean cultivar trials<br>AS de Beer , L Bronkhorst, HSJ Vermeulen, NN Mogapi, TC Ramatlotlo and S Seutlwadi | ARC Grain Crop Institute |
| 2. | Determining root-knot nematode resistance in soybean genotypes in South Africa<br>H Fourie | North West University |
| 3. | Cultivar evaluation of oil and protein seeds in the winter rainfall area<br>PJA Lombard, L Smorenburg and JA Strauss | Department of Agriculture: Western Cape |

## III SHORT- AND MEDIUM-TERM DEMAND AND USAGE OF FISHMEAL AND OILCAKE

(Updated February 2017)

TABLE 1: FISH MEAL AND OIL CAKE BALANCE SHEET (2014/2015 - 2016/2017) (APRIL - MARCH)

| | FISH MEAL (TON) | | | OIL CAKE (TON) | | |
|---|---|---|---|---|---|---|
| Year | 2014/2015 | 2015/2016 | 2016/2017 | 2014/2015 | 2015/2016 | 2016/2017 |
| Requirements/Sales | 45,000 | 20,000 | 20,000 | 1,966,459 | 1,981,986 | 1,820,298 |
| Available/Produced | 85,000 | 78,000 | 78,000 | 1,170,699 | 1,299,277 | 1,097,298 |
| *Shortage/Imports* | ***-40,000*** | ***-58,000*** | ***-58,000*** | ***795,760*** | ***682,709*** | ***723,000*** |

2015/2016 - Estimate
Source: Fishing industry;

TABLE 2: FISH MEAL AND OIL CAKE USAGE (2013/2014 - 2015/2016) (APRIL - MARCH)

| | FISH MEAL (TON) | | | OIL CAKE (TON) | | |
|---|---|---|---|---|---|---|
| Year | 2014/2015 | 2015/2016 | 2016/2017 | 2014/2015 | 2015/2016 | 2016/2017 |
| AFMA Members | 23,185 | 12,178 | 23,185 | 1,343,025 | 1,385,703 | 1,345,937 |
| Non-AFMA Members | 21,815 | 7,822 | 21,815 | 623,434 | 596,283 | 474,361 |
| *Total* | ***45,000*** | ***20,000*** | ***45,000*** | ***1,966,459*** | ***1,981,986*** | ***1,820,298*** |

Source: AFMA websit www.afma.co.za
2015/2016 - Estimate
* Non-AFMA Members figures can also include unused stocks

TABLE 3: THE MAIN RAW MATERIAL USAGE BY AFMA-MEMBERS (APR - MARCH) (2013/2014 - 2015/2016)

| RAW MATERIALS | TOTAL (TON) (2014/2015) | INCLUSION RATE (%) | TOTAL (TON) (2015/2016) | INCLUSION RATE (%) | TOTAL (TON) (2016/2017) | INCLUSION RATE (%) |
|---|---|---|---|---|---|---|
| Sunflower oilcake | 294,583 | 4.58 | 308,633 | 4.30 | 293,787 | 4.40 |
| Groundnut oilcake | 1917 | 0.03 | 573 | 0.01 | 0 | 0.00 |
| Soya oilcake | 821,670 | 12.78 | 936,283 | 13.03 | 919,454 | 13.76 |
| Full fat soya | 75,267 | 1.17 | 72,415 | 1.01 | 63,879 | 0.96 |
| Cottonseed oilcake | 20,892 | 0.32 | 8,888 | 0.12 | 9,354 | 0.14 |
| Full fat cottonseed | 10,340 | 0.16 | 7,845 | 0.11 | 10,121 | 0.15 |
| Canola oilcake | 23,555 | 0.37 | 38,109 | 0.53 | 38,767 | 0.58 |
| Full fat canola | 0 | 0.00 | 546 | 0.00 | 597 | 0.00 |
| Copra and Palm kern | 23,231 | 0.36 | 11,568 | 0.16 | 9,978 | 0.15 |
| Maize germ oilcake | 1,368 | 0.02 | 843 | 0.01 | 0 | 0.00 |
| Total oilcake | ***1,343,025*** | ***19.79*** | ***1,385,703*** | ***19.29*** | ***1,345,937*** | ***20.15*** |
| Total maize products | ***3,493,998*** | ***51.69*** | ***3,595,160*** | ***50.05*** | ***3,426,972*** | ***51.29*** |
| Total fish meal | ***23,185*** | ***0.31*** | ***12,178*** | ***0.17*** | ***12,825*** | ***0.19*** |
| Feed | ***6714004*** | | ***6908424*** | | ***6680988*** | |

Source: AFMA website www.afma.co.za
AFMA rawmaterial usage April 2016- March 2017 extrapolated from first 8 month usage
[1]Note: Total oilcake in Table 3 include all oilcake and not only specific oilcake items listed in table 3

TABLE 4: FISH MEAL: LOCAL PRODUCTION & IMPORTS (2013/2014 - 2015/2016) (APRIL - MARCH)

| | LOCAL (RSA + NAMIBIA) FISH MEAL PRODUCTION (TON) | | | | IMPORTED FISH MEAL (TON) | | |
|---|---|---|---|---|---|---|---|
| Year | 2012/2013 | 2013/2014 | 2014/2015 | 2015/2016 | 2013/2014 | 2014/2015 | 2015/2016 |
| RSA | 70,000 | 65,000 | 62,000 | 64,600 | | | |
| Namibia(i) | 14,000 | 13,000 | 13,000 | 13,000 | | | |
| *Total* | ***84,000*** | ***78,000*** | ***75,000*** | ***77,600*** | ***0*** | ***0*** | ***0*** |

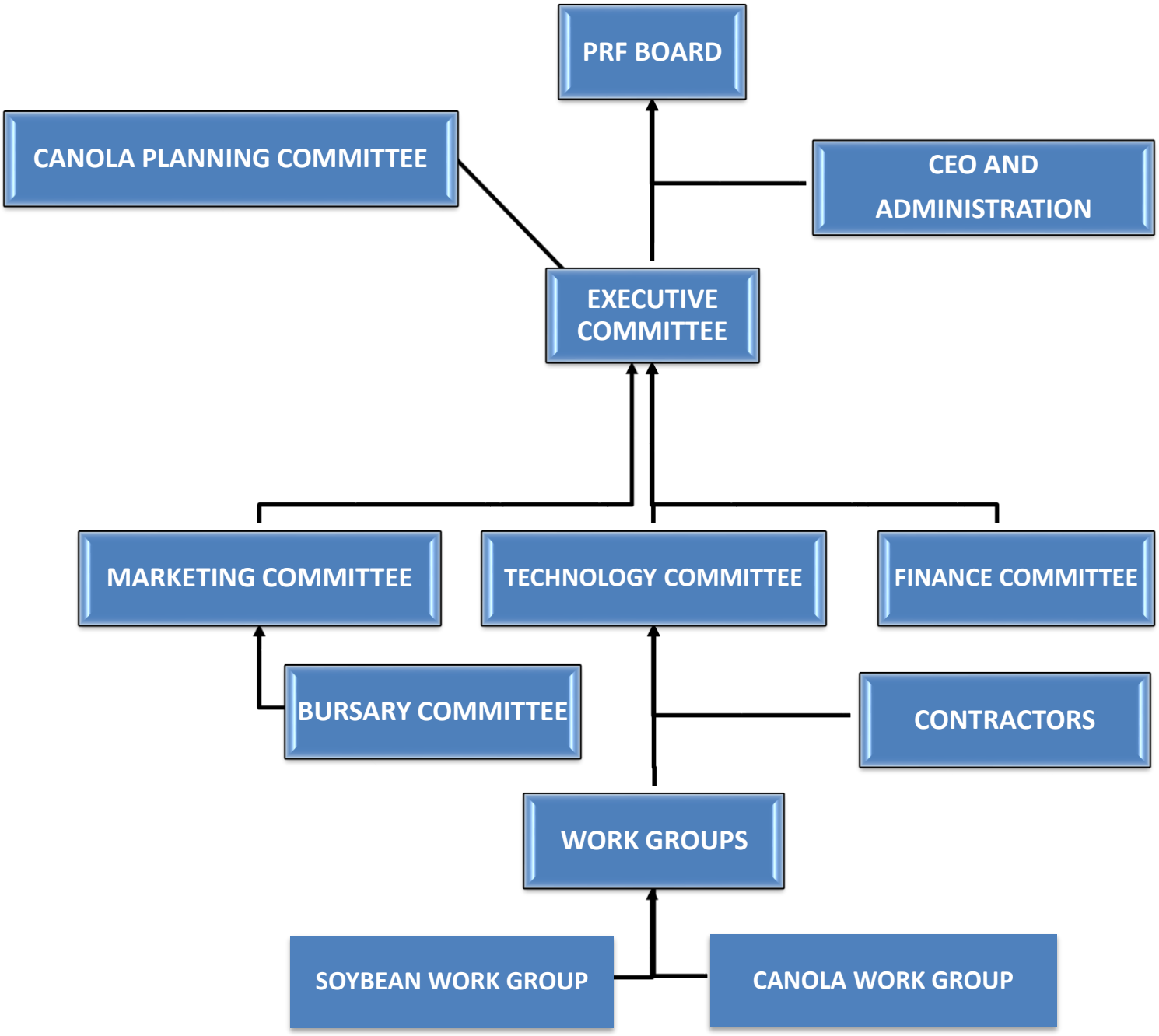
Source: AFMA; SA Fishmeal Marketing Company
2015/2016-Estimate.
(i) Includes Russian trawlers operating in Namibian waters

TABLE 5: OIL CAKE: LOCAL PRODUCTION AND IMPORTS (2014/2015 - 2016/2017)

| | LOCAL OIL CAKE PRODUCTION (TON) | | | IMPORTED OIL CAKE (TON) | | |
|---|---|---|---|---|---|---|
| Year | 2014/2015 | 2015/2016 | 2016/2017 (Projected) | 2014/2015 | 2015/2016 | 2016/2017 (Projected) |
| OIL CAKE: | | | | | | |
| Groundnuts oilcake | 0 | 0 | 0 | 588 | 0 | 0 |
| Sunflower oilcake | 320,842 | 280,368 | 262,200 | 166,273 | 67,887 | 70,000 |
| Soya Cake | 654,839 | 750,898 | 646,000 | 609,613 | 587,692 | 618,000 |
| - Full fat | 118,598 | 121,763 | 105,000 | | | |
| | | | | | | |
| Cotton Cake | | | | 98,478 | 59,468 | 9,000 |
| - Full fat | 8,740 | 19,098 | 19,098 | 11,749 | 25,898 | 11,000 |
| Other | | | | | | |
| Canola | 53,680 | 51,150 | 51,000 | 0 | 0 | 0 |
| Lupins | 14,000 | 6,000 | 14,000 | 0 | 0 | 0 |
| Copra & Palm Kernel | | | | 57,035 | 24,713 | 15,000 |
| *Total* | ***1,170,699*** | ***1,229,277*** | ***1,097,298*** | ***943,736*** | ***765,658*** | ***723,000*** |

Source: SAGIS www.sagis.org.za
Estimate - 2016/17 .The projected local production figures for soja and cotton reflect fullfat and oilcake
South African Supply and Demand Estimate Report NAMC 13 February2017

## IV PRF STRUCTURES



## V LIST OF BURSARY APPLICATIONS: 1995 - 2016

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| | **1995** | | | | | | | |
| 1 | Ms E Upton<br>**Promotor: Dr J Coetzee** | BSc (Agric),<br>BSc (Agric) (Hons) | Stellenbosch University | Dierevoeding: Ontwikkeling van polimeerbedekte ureum | Development and evaluation of polymer coated urea as a potential slow-release urea supplement for ruminants. | **M.Sc** | Received 2000 | H |
| 2 | Mr GE Schroeder | BSc (Agric),<br>BSc (Agric) (Hons),<br>MSc (Agric) | University of Pretoria | Melkbeesvoeding | Availability and partitioning of amino acids from various heat processed Protein sources to the Mammary gland of Lactating Dairy Cows. | **PhD** | Received 1998 | H |
| | **1996** | | | | | | | |
| 3 | Mr HM Böhme<br>**Promotor:**<br>**Prof CW Cruywagen** | BSc (Agric),<br>BSc (Agric) (Hons) | Stellenbosch University | Die evaluering van 'n stadige-vrystellende ureum produk. | Evaluering van die insluiting van 'n kommersiële stadig vrystellende ureum-melasseproduk (Ureïed) in lekke vir skape op laergraadse ruvoer. | **M.Sc** | Received 1998 | H |
| 4 | Ms MB Young | BSc (Agric) | University of KwaZulu-Natal | Development of simulation model to determine the economic optimum amino acid supply for laying hens and broiler breeders. | An evaluation of effective energy in the formulation of diets for laying hens. | **M.Sc** | Received 2000 | P |
| 5 | Mr AV Ferreira<br>**Promotor:**<br>**Prof JH van der Merwe** | BSc (Agric),<br>BSc (Agric) (Hons),<br>MSc (Agric) | University of the Free State | Die essensiële aminosuurbehoeftes van SA Vleismerinoramlammers. | The essential amino acid requirements of South African Mutton Msrino lambs. | **PhD** | Received 2000 | H |
| 6 | Mr CA Loëst | BSc (Agric),<br>BSc (Agric) (Hons),<br>MSc (Agric) | University of the Free State | Amino acid utilization by beef cattle. | Amino acid profile of lamb carcass and duodenal digesta content | **PhD** | Received 2000 | H |
| | **1997** | | | | | | | |
| 7 | Ms L McLouglin | BSc (Agric) | University of KwaZulu-Natal | Broiler breeder nutrition and simulation modelling. | An investigation of factors influencing rate of lay, egg weight and embryonic growth in Broiler breeder hens. | **M.Sc** | Received 2000 | P |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 8 | Mr PDR van Heerden<br>**Promotor: Prof GHJ Kruger** | BSc,<br>BSc (Hons),<br>MSc | PU for CHE | Die evaluering van de novo proteïensintese, chlorofilfluoressensie-induksieparameters en ensiemaktiwiteite van oksidatiewe stresmetabolisme as indikatore van droogte toleransie in Glycine max(sojaboon). | Physiological and Biochemical basis of dark chilling and superimposed drought stress in Glycine max (L.) Msrrill. | **PhD** | Received 2000 | S |
| | **1998** | | | | | | | |
| 9 | Ms A Booysen | BSc,<br>BSc (Hons) | PU for CHE | Die evaluering van faktore wat stikstof-binding by sojabone beïnvloed asook die impak daarvan op saadproteïen-inhoud. | Factors affecting biological nitrogen fixation as assessed by the ureide technique in Glycine Max L. (Msrrit) and its implication on soybean production in South Africa | **M.Sc** | Received 2001 | S |
| 10 | Ms GJM Coetzee<br>**Promotor: Dr LC Hoffman** | BSc (Agric) | Stellenbosch University | Gebruik van canola-oliekoek vir visvoeding. | Effects of feeding omega-3 fatty acids and Vitamin E on the chemical composition and microbial population of Broiler meat. | **M.Sc** | Received 2000 | VV |
| 11 | Mr CM Coetzer | BSc (Agric),<br>BSc (Agric) (Hons),<br>MSc (Agric) | Kansas State University | Manipulation of ruminal degradability characteristics of various protein sources. | Msthionine metabolism in growing cattle | **PhD** | Received 2001 | H |
| | **1999** | | | | | | | |
| 12 | Mr J van E Nolte<br>**Promotor: Dr AV Ferreira** | BSc (Agric) | Stellenbosch University | An evaluation of degradable intake protein and non-protein nitrogen on intake and digestion by Dohne Msrino sheep fed wheat straw. | An evaluation of degradable protein and non-protein Nitrogen on intake and digestion by Dohne Msrino sheep fed wheat straw. | **M.Sc** | Received 2001 | H |
| 13 | Mr PGW Wessels<br>**Dr PJ Pieterse** | BSc (Agric) | Stellenbosch University | Canola en lupien as wisselbougewasse. | Soil Nitrogen Dynamics and spring wheat (Triticum Aestivum)production in different cropping systems in the Swartland. | **M.Sc** | Received 2001 | C |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 14 | Mr WD Jonker<br><br>**Promotor:**<br>**Prof GHJ Kruger** | BSc | PU for CHE | Waterhuishouding van sojabone onder Suid-Afrikaanse toestande. | Invloed van vog- en ligstremming op die ontwikkeling en Bioproduktiwiteit van Glycine max (L.) merr. Genotipes van verskillende volwassenheidsgroeperings. | **M.Sc** | Received 2000 | S |
| | **2000** | | | | | | | |
| 15 | Mr GDJ Scholtz<br><br>**Promotor:**<br>**Prof HJ van der Merwe** | BSc (Agric),<br>BSc (Agric) (Hons) | University of the Free State | Lusern gradering stelsel. | Models for lucerne quality grading. | **M.Sc** | Received 2002 | LU |
| 16 | Mr S Tyiso | BSc,<br>HDE,<br>BSc (Hons),<br>MSc | University of KwaZulu-Natal | Development and maturation-drying effects on the biochemistry (lipid, protein lipid hydroperoxides, antioxidants) of soybean seeds. | Lipid Peroxidation and the antioxidant system in soybean seed maturation and germination. | **PhD** | Received 2004 | S |
| 17 | Mr JR Sara | BSc,<br>BSc (Hons),<br>MSc | University of KwaZulu-Natal | The formulation of a nutritional feed for prawn mariculture in KZN. | An investigation into the Protein Requirement of Marine Prawn Fenneropenaeus indicus (H. Milne Edwards) | **PhD** | Received May 2007 | VV |
| 18 | Mr JD Thornton<br><br>**Promotor: Dr AV Ferreira** | BSc (Agric) | Stellenbosch University | Comparison of different RDP and UDP ratio's on intake and milk production efficiency in Saanen goats fed a complete diet. | The effect of dietary protein degradability on the performance of Saanen Dairy Goats. | **M.Sc** | Received 2003 | H |
| | **2001** | | | | | | | |
| 19 | Ms S Nel<br><br>**Promotor: Dr J Albertyn** | BSc,<br>BSc (Hons) | University of KwaZulu-Natal | The cloning expression and characterization of a xylanase to improve the feed conversion ratio in chickens. | Cloning of the xyna gene from thermomyces lanuginosus and expression in saccharomyces cerevisiae. | **M.Sc** | Received 2002 | P |
| 20 | Mr SG de Jager<br><br>**Promotor:**<br>**Prof CC du Preez** | BSc (Agric),<br>BSc (Agric) (Hons) | University of the Free State | Groei en ontwikkeling van sojaboon-kultivars by verskillende rywydtes. | Groei en ontwikkeling van sojaboon cultivars by verskillende rywydtes. | **M.Sc** | Received 2004 | S |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 21 | Mr M de Beer<br>**Promotor: Prof LG Ekermans** | BSc (Agric) | Stellenbosch University | Animal Nutrition | The influence of processing of Soya-beans and Sunflower seed on their Energy and Amino Acid availability for poultry. | **M.Sc** | Received 2003 | P |
| 22 | Ms L Brundyn<br>**Promotor: Dr AV Ferreira** | BSc (Agric) | Stellenbosch University | Die voedingswaarde en benutting van canola- en koringstoppel deur skape. | The utilization and supplementation to stubble lands for South African mutton Msrino ewes. | **M.Sc** | Received 2003 | H |
| | **2002** | | | | | | | |
| 23 | Ms H Fourie | BSc,<br>HOD,<br>BSc (Hons),<br>MSc | Catholic, University of Leuven, België | **A.** Identification and verification of soybean genotypes resistant to M. incognita race 2 (greenhouse, micro plot and field trials). **B.** Identification and validation of genetic markers associated with this resistance trait (breeding and biotechnology). | In vivo evaluation of resistance to Msloidogyna incognita race 2 (Nematode: Tylenchida) and identification of genetic markers for this trait in soybean (Glycine max). | **PhD** | Received 2005 | S |
| 24 | Ms MM Viljoen<br>**Promotor: Prof GHJ Kruger** | BSc,<br>BSc (Hons) | PU for CHE | The influence of dark chilling on the endogenous rhythms of photosynthesis and sucrose synthesis in Glycine max (L.) Msrr. | The influence of dark chilling on the endogenous rhythms of photosynthesis and sucrose synthesis in Glycine max(L.) Msrr. | **M.Sc** | Received 2004 | S |
| | **2003** | | | | | | | |
| 25 | Ms LR Breytenbach<br>**Promotor: Dr M Ciacciariello** | BSc (Agric) (Hons) | Stellenbosch University | The influence of processing of canola and lupins on the amino acid availability for broilers. | The influence of processing of lupins and canola on apparent metabolizable energy and broiler performance. | **M.Sc** | Received February 2006 | P |
| 26 | Mr SG Payne | BSc (Agric) (Hons) | Stellenbosch University | Evaluasie van grondstowwe in pluimvee- en varkvoeding. | The Phosphorus availability of feed phosphates in broilers. | **M.Sc** | Received June 2005 | P |
| 27 | Ms JB Griffiths<br>**Promotor: Prof CW Cruywagen** | BSc (Agric) (Hons) | Stellenbosch University | Herkouer voeding | The effect of extrusion on the degradability parameters of various vegetable protein sources. | **M.Sc** | Jan-06 | H |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 28 | Mr D Backhouse<br>**Promorot: Prof RM Gous** | BSc (Agric) | University of KwaZulu-Natal | Poultry nutrition (specifically broiler breeder nutrition and lighting). | The effect of photoperiod and feeding time on broiler breeder eggshell quality and oviposition time. | **M.Sc** | Received 2005 | P |
| | **2004** | | | | | | | |
| 29 | Ms ER Malleson<br>**Promotor:<br>Prof LJ Erasmus** | BSc (Agric) Veekunde | University of Pretoria | The effect of ruminal pH on the protein degradability of typical dairy and feedlot diets. | Fishmeal Supplementation to high producing jersey cows grazing ryegrass or kikuyu pasture. | **M.Sc** | Received March 2008 | H |
| 30 | Ms Z Bester<br>**Promotor:<br>Prof LJ Erasmus** | BSc (Agric) Veekunde | University of Pretoria | Die effek van rumen-beskermde metionien (RPMst) op die produktiwiteit van Holstein-koeie gedurende vroeë laktasie. | Evaluation of a liquid rumen protected methionine source using different techniques | **M.Sc** | Received September 2011 | H |
| 31 | Ms N Smith<br>**Promotor: Prof TS Brand** | BSc (Agric) Veekunde | Stellenbosch University | Gebruik van canola en lupiene in die diëte vir braaikuikens, volstruise en varke. | The effect of dietary inclusion of canola oilcake, full-fat canola and sweet lupins on the production performance and fat composition of broilers and pigs. | **M.Sc** | Received 2005 | P |
| | **2005** | | | | | | | |
| 32 | Mr W Visagie<br>**Promotor: Dr F van de Vyver** | BSc (Agric) Veekunde | Stellenbosch University | Essential amino acid requirements of goats. | The digestibility and degradability of feeds and protein sources in dohne - merino sheep and boer goats | **M.Sc** | Received January 2010 | H |
| 33 | Mr J Fourie<br>**Promotor:<br>Dr M Ciacciariello** | BSc (Agric) | Stellenbosch University | Use of enzymes for vegetable protein sources in poultry. | The effects of a multiple-enzyme combination in maize-soya diets for broiler chickens. | **M.Sc** | Received August 2007 | P |
| 34 | Ms M Kritzinger<br>**Promotor: Dr Helet Lambrechts** | BSc (Agric) | Stellenbosch University | The effects of probiotics in gut health and protein utilization in poultry. | Alternatives to replace antibiotics in broiler diets: Effects on protein utilization and production performance | **M.Sc** | Received November 2009 | P |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| | 2006 | | | | | | | |
| 35 | Ms MR Modiba<br>**Promotor: Prof I Ncube** | BSc Microbiology | University of Limpopo | Animal Nutrition: Use of fermentation Technologies to develop Jatropha curcas seed meal into animal stockfeed. | Evaluation of solid state fermentation in the detoxification of Jatrpoha curcas seed press cake | **M.Sc** | Received November 2009 | H |
| 36 | Mr SF Magoda<br>**Promotor: Prof RM Gous** | BSc (Agric) | University of KwaZulu-Natal | Poultry nutrition (alternative protein source for Laying Hens). | Poultry nutrition (alternative protein source for Laying Hens). | **M.Sc** | Received June 2010 | P |
| 37 | Mr H Nienaber<br>**Promotor: Prof LJ Erasmus** | BSc (Agric), BSc (Hons) | University of Pretoria | The effect of ruminal pH on protein degradability. | Effect of roughage to concentrate ratio on ruminal fermentation and protein degradability in dairy cows. | **M.Sc** | Received August 2008 | H |
| | 2007 | | | | | | | |
| 38 | Ms M. Strydom<br>**Promotor: Dr TS Brand** | BSc (Agric) | Stellenbosch University | Diere voeding ten opsigte van die monogastriese dier (Enkelmaagdier). | The effect of different levels of supplementary feed on the production of finisher ostriches (Struthio camelus) grazing irrigated lucerne (Msdico stiva) pastures | **M.Sc** | Received April 2011 | P |
| 39 | Ms BK Theeruth<br>**Promoter: Prof RM Gous** | BSc (Animal & Poultry Science)<br>MSc (Animal Science) | University of KwaZulu-Natal | Evaluating an optimisation routine for the profitable feeding of growing pigs. | Selecting suitable mathematical functions to describe the time course of anorexia during pathogen challenge | **M.Sc** | Received April 2009 | V |
| 40 | Mr DB Strydom<br>**Promotor: Dr P Taljaard** | B.Com | University of the Free State | Die ekonomiese impak van hernubare brandstof produksie op die Suid-Afrikaanse veevoer bedryf. | The economic impact of maize-based ethanol production on the South African Animal Feed Industry | **M.Sc** | Received March 2009 | P |
| | 2008 | | | | | | | |
| 41 | Mr TL Khetani<br>**Promotor: Dr M Ciacciariello** | BScAgric | University of KwaZulu-Natal | An evaluation of the effects of feed restriction on protein intake and its consequences on egg composition and incubation success in broiler breeder hens. | The effects of maternal dietary lysine intake on broiler breeder offspring performance | **M.Sc** | Received June 2011 | P |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 42 | Ms PT Mabulwana<br>**Promotor: Dr PW Mokwala** | BSc (Botany & Microbioloby), BSc Honour (Botany) | University of Limpopo | Determination of drought stress tolerance among soybean varieties by morphological and physiological charactistics. | Determination of drought stress tolerance among soybean varieties using morphological and physiological markers | **M.Sc** | Received July 2013 | S |
| | **2009** | | | | | | | |
| 43 | Mr SB Ruck<br>**Promotor: Dr NC Tyler** | BSc Honours (Animal Science) | University of KwaZulu-Natal | The effect of protein in the diet of broiler breeders on egg fertility and hatchability. | The response of broiler breeder hens to dietary lysine: hatchability, embryo growth and subsequent offspring performance | **M.Sc** | Received March 2012 | P |
| 44 | Ms J Patel<br>**Promotor: Dr M Ciacciariello** | BSc Honours (Animal & Poultry Science) | University of KwaZulu-Natal | The effect of dietary lysine, crude protein, energy and feed allocation on broiler breeder hen performance. | The effect of dietary lysine, crude protein, energy and feed allocation on broiler breeder hen performance. | **M.Sc** | Received January 2015 | P |
| 45 | Mr TR Olivier<br>**Promotor: Prof TS Brand** | BSc (Agric) | Stellenbosch University | Monogastriese voeding | Determination of the nutrient requirements of breeding ostriches | **M.Sc** | Received May 2010 | P |
| 46 | Mr EJ van der Westhuizen<br>**Promotor: Prof TS Brand** | BSc (Agric) | Stellenbosch University | Veekunde (Vleiskunde) | The effect of slaughter age on the lamb characteristics of Marino, South African Mutton Marino and Dorper lambs | **M.Sc** | Received May 2010 | H |
| | **2010** | | | | | | | |
| 47 | Ms MM Minnaar<br>**Promotor: Prof GHJ Kruger** | Honneurs (Plantbeskerming) BSc (Omgewingswetenskappe) | Northwest University | Die invloed van verhoogde swaeldioksied ($SO_2$) word gekwantifiseer op canola plante | Constraints on photosynthesis and antioxidant metabolism in winter and summer crops induced by sulphur dioxide fumigation | **M.Sc** | Received June 2013 | C |
| 48 | Ms AM Jooste<br>**Promotor: Prof WA van Niekerk** | B.Sc (Agric) | University of Pretoria | The effect of supplementing slow release nitrogen (optigen II) and FME on the degradability of poor quality roughage in sheep | The effect of supplementing slow release nitrogen (optigen II) and FME on the degradability of poor quality roughage in sheep | **M.Sc** | Received September 2012 | H |
| 49 | Ms S Greaves<br>**Promotor: Dr C Jansen van Rensburg** | B.Sc (Agric) | University of Pretoria | The effect of specific amino acids-lysine, Tryptophan, Thyptophan, Theonine of the immune system of weaning piglets. | Growth and immunity of weaner piglets supplemented with dietary tryptophan, threonine and glutamine. | **M.Sc** | Received May 2015 | V |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 50 | Mr WJ Kritzinger<br>**Promotor: Prof TS Brand** | B.Sc (Agric) | Stellenbosch University | Volstruis (Groei en voeding) | Allometric description of ostrich (*Struthio camelus var. Dometricus*) growth and development | **M.Sc** | Received April 2012 | P |
| | **2011** | | | | | | | |
| 51 | Mr PD Carstens<br>**Promotor: Prof TS Brand** | B.Sc Agric | Universiteit van Stellenboch | Diere Voeding en Vleiskunde | Studies to develop a mathematical optimisation model to desribe the effect of nutrition on the growth of ostriches (*Struthio camelus* var. *domesticu* s) | **M.Sc** | Received July 2014 | P |
| 52 | Mr FV Meyer<br>**Promotor: Prof RM Gous** | B.Sc (Agric) Animal Science | University of Pretoria | The response of weaned piglets to varing dietary levels of synthetic valine and leucine | The response of weaned piglets to varing dietary levels of synthetic valine and leucine | **M.Sc** | Received August 2012 | V |
| 53 | Ms M du Plessis<br>**Prof KJ Kunert** | B.Sc (Biotechnology) B.Sc (Hons) Plant biotechnology | University of Pretoria | Soybean nodule development | Cysteine proteases activity and gene expression studies in soybean nodules during development and drought stress | **M.Sc** | Received July 2013 | S |
| 54 | Ms SL von Waltsleben<br>**Promotor: Dr N Tyler** | B.Sc (Agric) | University of KwaZulu-Natal | Determine whether feed restriction through different levels of crude protein has any influence on the fertility in broiler breeder males | The effect of dietary crude protein on fertility of broiler breeder males | **M.Sc** | Received June 2013 | P |
| | **2012** | | | | | | | |
| 55 | Ms MP Genis<br>**Promotor: Prof LC Hoffman** | BSc Agric (Veekunde met Agronomie) | Stellenbosch University | Herkouer voeding | The effect of dietary energy content and the provision of a *Beta* -adrenergic agonist in the diet on the production and meat quality of South Africa mutton merino feedlot lambs | **M.Sc** | Received July 2014 | H |
| 56 | Ms L van Emmenes BSc Agric (Veekunde)<br>**Promotor: Dr E Pieterse** | BScAgric (Animal Science as a major) 2011 | Stellenbosch University | MSc Monogastriese voeding | Evaluation of phytase enzymes on performance, bone mineralisation, carcass characteristics and small intestinal morphology of broilers fed maize soya bean diets. | **M.Sc** | Received February 2015 | P |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 57 | Mr R Steyn<br>**Promotor: Dr D Strydom** | BScAgric (Veekunde / Landbou - ekonomie)<br>Landbou ekonomie Honneurs | University of the Free State | Canola-olie | When does a market qualify as a niche market: A canola case study | **M.Sc** | Received December 2014 | C |
| 58 | Ms GA Tesselaar<br>**Promotor: Prof TS Brand** | BScAgric (Animal Science with Conservation Ecology) 2010 | Stellenbosch University | MSc Monogastriese Voeding | Development of a methematical optimization model for breeding ostriches: Identification of possible factors affecting feed intake and production | **M.Sc** | Received February 2015 | P |
| | **2013** | | | | | | | |
| 59 | Mr LL Eksteen<br>**Promotor: Prof GA Agenbag** | BScAgric (2012) | Stellenbosch University | Die gebruik van groeireguleerders in canola | Reducing height and lodging in canola (*Brassica napus L.*) using plant growth regulators | **M.Sc** | Received November 2014 | C |
| 60 | Ms TC Maluleke<br>**Promotor: Dr BJ Vorster** | BSc Genetics (2011)<br>BSc Hons (2012) | University of Pretoria | Plant Cystatins and insect resistance: Inhibition of insect midgut cysteine proteases by plant cystatins and their role in plant insect resistance | Plant Cystatins and insect resistance: Inhibition of insect midgut cysteine proteases by plant cystatins and their role in plant insect resistance | **M.Sc** | studies not completed yet | D |
| 61 | Ms M Cilliers (*nee* Du Plessis)<br>**Promotor: Dr BJ Vorster** | B.Sc (2009)<br>B.Sc Hons (2010)<br>M.Sc (2012) | University of Pretoria | Molecular markers for drought tolerance in soybean | Molecular markers for drought tolerance in soybean | **PhD** | studies not completed yet | S |
| 62 | Ms GC Buitendach<br>**Promotor: Mr FH de Witt** | B.Sc Animal Science (2009)<br>B.Sc (Hons) 2011 | University of the Free State | Animal Nutrition | Effect of long-term exposure to different dietary fatty acids on production and egg quality of layers | **M.Sc** | Received August 2015 | P |
| | **2014** | | | | | | | |
| 63 | Mr MN Engelbrecht<br>**Promotor: Prof CW Cruywagen** | BSc Landbou ekonomie (2013) | Stellenbosch University | Afronding van beeste op aangeplante weidings met byvoeding van volvet kanola en/of ander hoë kwaliteit proteïenbron | The effect of supplements containing different protein and energy sources and essential oils on the performance of pasture finished heifers | **M.Sc** | studies completed Dec 2015 | H |
| 64 | Miss T Khahlu<br>**Promotor: Dr BJ Vorster** | BSc (Biotechnology) (2010-2012) | University of Pretoria | Drought tolerance markers in soybean | Drought tolerance markers in soybean | **M.Sc** | studies not completed yet | S |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 65 | Mr HCvdW Leicester<br><br>**Promotor:**<br>**Prof LJ Erasmus** | BSc Animal Science (2011)<br>BSc Honours (2012) | University of Pretoria | Animal nutrition examining the effect of a quality roughage as a determinant of nitrogen efficiency in dairy cows | Effects of yeast based direct fed microbial supplementation on the performance of high producting dairy cows. | **M.Sc** | Received September 2015 | H |
| 66 | Ms E Jordaan<br><br>**Promotor:**<br>**Prof J van der Waals** | BSc (Agric Plant Pathology (2008)<br>MSc (Agric) Plant Pathology (2014) | University of Pretoria | Epidemiology and population on structure of Macrophomina phaseolina (Charcoal rot) on sunflower and soybean in South Africa (TBC) | Epidemiology and population on structure of Macrophomina phaseolina (Charcoal rot) on sunflower and soybean in South Africa (TBC) | **PhD** | studies not completed yet | S |
| | **2015** | | | | | | | |
| 67 | Mr W de Jager<br><br>**Promotor:**<br>**Dr Dirk Strydom** | BSc Agric Animal Science and Agricultural Economics (2013) | University of the Free State | An integrated model to project animal protein consumption in South Africa | Forecast estimates of protein for animals in South Africa | **M.Sc** | Received 15 December 2016 | D |
| 68 | Ms L van Emmenes<br><br>**Promotor: Dr E Pieterse** | BSc Agric (Animal Science (2011)<br>MSc Agric (Animal Science) (2014) | Stellenbosch University | The use of fly larvae meal as an alternative protein source in the diets of monogastric animals. Exploring the potential benefits for the animal, farmer, consumer and environment | The use of fly larvae meal as an alternative protein source in the diets of monogastric animals. Exploring the potential benefits for the animal, farmer, consumer and environment | **PhD** | studies not completed yet | D |
| 69 | Ms KZ Neethling<br><br>**Promotor:**<br>**Prof CW Cruywagen** | BSc.agric (Veekunde) (2013) | Stellenbosch University | Die effek van verskillende kombinasies van proteien en energie bronne op veselvertering van ruvoere | The effect of different energy and nitrogen sources on *In Vitro* fibre digestion and gas production kinetics of high and low quality forages | **M.Sc** | elektoniese kopie van tesis ontvang op 26/03/17. Harde kopie word afgewag | D |
| 70 | Ms JA Engelbrecht<br><br>**Promotor: Prof T Brand** | BSc (Animal Science) (2014) | Stellenbosch University | The evaluation of alternative protein sources (lupins, canola and canola oilcake in ostrich nutrition) | The evaluation of lupins (*Lupinus angustifolius*) as alternative protein source to soybean oilcake meal in ostrich (*Struthio camelus* var. *domesticus*) diets | **M.Sc** | elektroniese kopie van tesis ontvang op 17/02/17. Harde kopie word afgewag | C |

| NO. | STUDENT | QUALIFICATIONS | INSTITUTION | PROPOSED RESEARCH AREA | TITLE OF THESIS | DEGREE | THESIS RECEIVED | CROP CODE |
|---|---|---|---|---|---|---|---|---|
| 71 | Mr A Coetzee<br><br>**Promotor:**<br>**Prof GA Agenbag** | BSc Agric (2011-2014) | Stellenbosch University | Stikstof bo-bemesting op canola: Tyd en toedieningstempo's | Determining the optimal rate and time of nitrogen topdressing applications for canola (*Brassica napus*) in the Swartland and Southern Cape production areas | **M.Sc** | elektroniese kopie van tesis ontvang op 17/02/17. Harde kopie word afgewag | C |
| | **2016** | | | | | | | |
| 72 | Mr PJG le Roux<br><br>**Promotor:**<br>**Dr P Swanepoel** | BSc Agric (Veekunde met Agronomie) (2015) | Stellenbosch University | Die evaluasie van tand- en skyf-oopmakers om canola te vestig op grond met verskillende fisiese, chemiese en biologiese toestande (grondkwaliteit) | Establishment, growth and yield of canola (*Brassica napus* L.) as affected by seed-drill opener, soil quality and stubble | **M.Sc** | studies not completed yet | C |

| | | |
|---|---|---|
| P | PLUIMVEE | 23 |
| H | HERKOUERS | 21 |
| V | VARKE | 3 |
| S | SOJABONE | 12 |
| C | CANOLA | 4 |
| LU | LUCERNE | 1 |
| VV | VISVOEDING | 2 |
| D | DIVERSE | 2 |

## VI LIST OF RESEARCH PROJECTS: 1976 - 2016 (Separate addendum)