PROTEIN RESEARCH FOUNDATION

2021-2022 RESEARCH REPORT

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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 its 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 utilisation.
- The promotion of cost-effective research.
- The dynamic promotion of the implementation of research results.
- The effective sustainable utilisation of natural agricultural resources.
- The reduction of foreign exchange payable for imports and creation of job opportunities by replacing imported protein as far as possible with locally produced protein.

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1. INTRODUCTION

During the 2021-2022 financial year the Board of Trustees once again succeeded in their efforts to achieve the objectives of the Trust as set out in the Trust Deed.

- Objectives of the Trust

The founding objectives and requirements of the Trust are to place the reserve funds earmarked for the financing of protein research, as provided for in Section 20(5) of the Agricultural Research Act of 1990, as well as all future donations provided for in Section 20(5)(c) of the Agricultural Research Act of 1990, in trust for research purposes to be allocated in the Republic of South Africa, as the Trustees may determine from time to time, for the purpose of research in either of the following fields:

(a) Protein Research

Research on protein sources destined for animal feed either of animal origin or from oilseeds and other protein rich plants.

(b) Oilcake Research

Research related specifically to the oilseed protein value chain.

1.1 Board of Trustees

The Trust is administered and managed by a Board of Trustees convened from various disciplines. During the 2021-2022 year the Board comprised of the following Trustees:

Mr AP Theron	-	Expert	:	Representative - Organised Agriculture - Producer of Protein Crops (Chairperson)
Dr E Briedenhann	-	Expert	:	Representative - Oilseeds Processors and Representative - Animal Feed Manufacturers (Vice-Chairperson)
Prof RM Gous	-	Expert	:	Discipline - Protein Consumers
Mr GT du T Keun	-	Expert at the discretion of the Board		
Prof FH Meyer	-	Expert	:	Discipline - Agricultural Economics

(i) General Overview

During the reporting period 1 March 2021 to 28 February 2022, the Trust met six (6) times. Two (2) of the meetings were combined with those of the Technology Committee.

During the period under review, R4 803 115 was approved in respect of research projects, technology transfer and bursaries.

The trust fulfilled the duties of funding and managing research projects and technology transfer, which form part of the core business of the PRF as set out as objectives in the Trust Deed. Furthermore, facilitation of the Soybean Value chain discussions continued, which made an important contribution to the Soybean Industry.

(ii) Financial Overview

(a) Investment and Management of Trust Funds

Two (2) portfolio managers, Foord and Old Mutual Wealth, manage the PRF Trust funds.

The performance of the respective portfolio managers is monitored and reviewed constantly. Apart from regular discussions, the Fund Managers are requested to deliver a presentation to the Board of Trustees at least once annually.

(b) Audit

Ashton Chartered Accountants are currently charged with auditing the financial affairs of the PRF.

As in the past, the auditors once again issued an unqualified audit report. The report noted the efficient operation and management of the affairs of the PRF by all concerned.

Together with the auditors, the financial and administrative systems, and specifically the financial reporting systems, are reviewed and upgraded in order to ensure financial stability and corporate governance.

1.2 Executive Committee

During the reporting period 1 March 2021 to 28 February 2022, the Executive Committee met six (6) times.

The Executive Committee may be considered an extension of the Board and provides recommendations relating to policy matters. The committee is also responsible for financial and marketing matters.

The Executive Committee consisted of the following members:

Mr AP Theron	-	Chairperson, Chairperson of the Board
Dr E Briedenhann	-	Vice-Chairperson of the Board and Chairperson of the Technology Committee
Prof FH Meyer	-	Board Member

1.3 Technology Committee

During the reporting period 1 March 2021 to 28 February 2022, the Technology Committee met four (4) times. Two (2) of the meetings were combined meetings with those of the PRF Board.

The Technology Committee consisted of the following members:

- Dr E Briedenhann (Chairperson)
- Mr AP Theron
- Prof RM Gous
- Dr J Dreyer (Co-opted Member)

The functions of the Technology Committee are as follows:

- The Technology Committee is one of four Board standing committees and reports directly to the Board.

- The Technology Committee is responsible for evaluating and selecting all research projects, promoting technology transfer, visiting researchers and research projects, identifying gaps and new topics related to research projects, and identifying new sources of supply and utilisation of protein for animal feeds.

1.4 Soybean Working Group

During the reporting period 1 March 2021 to 28 February 2022, the Soybean Working Group met four (4) times.

The functions of the Soybean Working Group involve the following:

- Discussion of industry matters in the interest and to the benefit of the Soybean industry.
- Identification of research projects and technology transfer to the benefit of the Soybean industry.

1.5 Canola Working Group

During the reporting period 1 March 2021 to 28 February 2022, the Canola Working Group met three (3) times.

The functions of the Canola Working Group involve the following:

- Discussion of industry matters in the interest and to the benefit of the Canola industry.

- Identification of research projects and technology transfer to the benefit of the Canola industry.

1.6 Canola Planning Committee

During the reporting period 1 March 2021 to 28 February 2022, the Canola Planning Committee met four (4) times.

The Canola Planning Committee consisted of the following members:

- Mr AP Theron (Chairman)
- Dr E Briedenhann
- Mr C Cumming
- Mr K Blanckenberg
- Mr F le Roux

The functions of the Canola Planning Committee involve the following:

- Discussion of industry matters and recommendations to the PRF committees as these relate to research, technology transfer, liaison and any other action required for the promotion of canola production.

1.7 Soybean Value Chain

During the reporting period 1 March 2021 to 28 February 2022, the Soybean Value Chain met twice (2).

The PRF is responsible for the facilitation of these discussions. Various actions were identified that were to the benefit of the Soybean Industry.

2. DISCIPLINES REPRESENTED ON THE BOARD

In the Trust Deed provision is made for representatives from various disciplines which may include the following:

- Animal feed manufacturers' industry
- Oilseed crushing industry
- Fish meal manufacturers' industry and marine research
- Plant Production
- Organised Agriculture
- Agricultural Economics

3. LIST OF PROJECTS FINALISED DURING 2020-2021

Eight (8) projects were finalised during the year, but the final reports are expected only in the first half of 2022.

3.1 **Dr SC Lamprecht** - 'Management strategies for soilborne diseases of soybean in South Africa', ARC-Plant Protection Research Institute.

3.2 **Dr J van der Waals** - 'Integrated management of charcoal rot (*Macrophomina phaseolina*) of agronomic crops in South Africa, with the emphasis on sunflower and soybeans', University of Pretoria.

3.3 **Dr N Goosen** - 'Increasing South African protein production through the development of value-added products for fish processing waste', University of Stellenbosch.

3.4 **Dr KS Yobo** - 'Studies on *Lecanicillium muscarium* as a microparasite of the soybean rust fungus, *Phakopsora pachyrhizi,* and its use as a biocontrol agent against soybean rust', University of KwaZulu-Natal.

3.5 **Prof GA Agenbag** - 'Chemical manipulation of vegetative growth reproductive development and grain yield in canola', University of Stellenbosch.

3.6 **Prof GA Agenbag** - 'Nitrogen topdressings in canola: Time of application and rates', University of Stellenbosch.

3.7 **Mr WJ du P Jonker / Prof GA Agenbag** - 'Canolanavorsing: Somerreënvalgebiede (Groblersdal; Brits: Beestekraal & Vaalharts)', Madifor.

3.8 **Ms AS de Beer** - 'Evaluation of soybean cultivars', ARC-Grain Crop Institute.

4. PROJECTS FINANCED 2021-2022

4.1 PRF CANOLA YIELD COMPETITION FOR CANOLA; C Cumming, Contractor, Protein Research Foundation

The format of the competition underwent a further change for the 2021 season. The whole farm/farming unit concept which had worked well for the previous season was retained, but all canola producers in the Western Cape were automatically incorporated as participants.

By doing away with the requirement to enter the competition individually all producers were eligible to win the competition, thereby increasing interest in the competition and promoting the concept of maximizing yields by adopting best practices. To facilitate the monitoring of results of all canola producers, the PRF joined forces with SOILL, who have access to all the relevant information required.

2021 proved to be a favourable year for canola production in both the Southern Cape and Swartland. The Swartland received slightly lower rainfall than the long term average for the region in June, July and September, but good rain in August and October together with cool conditions throughout the flowering and pod filling stages resulted in above average yields being realised in most of the region.

The Southern Cape season started with torrential rains being experienced in large parts of the region in May. In Tygerhoek, for example, 397 mm of rain was recorded for the month and some lands suffered severe soil erosion. In the western part of the Southern Cape some lands could only be planted in June due to saturated soils. Although slightly lower than average rainfall was experienced for the rest of the season, with the exception of July, the below average temperatures recorded during flowering and seed set resulted in excellent yields being achieved.

Recognition was given to the top three growers from each region for the categories producers planting 50 to 150 ha, those planting more than 150 ha, while an additional category was added for the best new canola producer in each region.

The top producers for 2021 were as follows:

Southern Cape:

Category 50 - 150 ha planted:

- Danie du Toit, Springerskuil Bdry, Caledon 2,72 ton/ha
- Chris Swart, Witklip Malanskraal Bdry, Bredasdorp 2,63 ton/ha
- Jan de Kock, Kograh Bdry, Caledon 2,57 ton/ha

Category >150 ha planted:

- Jan Paul Kempen, Amerika Landgoed, Klipdale 3,03 ton/ha
- Philip Morkel, Quarrie Bdry, Klipdale 2,72 ton/ha
- Johan Fourie, Broodkas Bdry, Heidelberg 2,41 ton/ha

New producer:

- Wynand Wessels, Wynarend Bdry, Napier 2,95 ton/ha

Swartland:

Category 50 - 150 ha planted:

- Thys Louw, Diemersdal Bdry, Klipheuwel 2,71 ton/ha
- Melt van der Westhuizen, Moorreesburg 2,56 ton/ha
- Dirk Lesch, D J Lesch Bdry, Malmesbury 2,50 ton/ha

Category > 150 ha planted:

- Hennie Walters, Walters Groep, Malmesbury 2,67 ton/ha
- Dolfie Walters, Rustfontein Bdry, Malmesbury 2,28 ton/ha
- A.J Louw, AJ Louw Bdry, Malmesbury 2,34 ton/ha

New producer :

Ewan van Heerden , Bakensig Bdry, Moorreesburg 2,32 ton/ha

Thanks to SOILL and specifically Zander Spammer, Agricultural Resource Manager at SOILL, for providing the information required and their co-operation in making the competition a success.

4.2 CANOLA TECHNOLOGY TRANSFER; C Cumming, Contractor, Protein Research Foundation

The canola information days were originally initiated to train agricultural chemical company employees and other personnel who were involved in advising producers on issues related to the production of canola. Over the years, persons from the Department of Agriculture, Universities, Agri - business and other institutions that provide inputs to canola production, as well as producers of canola themselves, have changed the configuration of attendees.

Due to Covid 19 restrictions prohibiting gatherings, the information day planned for early 2021 could only be presented in May 2021 in the Hopefield Sports club, Hopefield. Presentations on climate change and related risks, cultivar evaluation feedback, choices for cover crops, and the latest research findings on Sclerotinia and Black Leg were made. Issues related to yield loss at harvesting and the oilseed market were also covered.

A total of 73 attendees were present and the event was concluded with a sumptuous lunch provided by the sports club personnel.

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

Summary of results and outputs during the 2021 production year.

2021 was the 10th year of production on the new trial. Six cash crop systems are tested including shortened canola rotations and cover crops. A total of 60 plots were planted. The 6 systems tested are replicated 3 times and all crops within each system are represented in the field each year.

All protocols developed during the annual technical committee meeting in February 20201 were followed and the integrity of the trial layout was upheld.

Wheat production - SST0166 was planted at Riversdale at 60 kg/ha. A total of 38 kg N/ha was applied to each plot (8 kg N/ha at planting and 30 kg N/ha top-dressing).

Wheat yields at Riversdale averaged 3042 kg/ha. This was 1463 kg/ha less than in 2020.

Canola production - 44Y90 was planted at Riversdale at 2.5 kg/ha. A total of 38 kg N/ha was applied to each plot. Nitrogen at plant was 8 kg/ha and a topdressing of 30 kg/ha was applied at the end of July. Canola yields at Riversdale averaged 1095 kg/ha which was 1055 kg/ha less than the 2020 average.

Barley production - Kadie was planted at Riversdale at 50 kg/ha. Barley yields at Riversdale averaged 4201 kg/ha. This average yield was 70 kg/ha more than in 2020.

Lupin production - Lupin plots were planted to bitter lupin SSL10 at a rate of 80 kg/ha. No plots were harvested. Good growth but poor seed set and poor weed control led to the termination of the lupin trial.

Cover crops - A mixture of peas, lupins and barley were planted during 2020 at seeding rates of 80 kg/ha.

Economics - Although commodity prices were excellent the problems with canola yields and rain during the harvesting period had a pronounced effect on the economics of the 2021 season.

4.4 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

Introduction

The Protein Research Foundation (PRF) has as its main objective the replacement of imported protein with domestically produced protein for animal feed. After many years of investigating numerous protein sources, the PRF decided to focus its research on soybeans and canola, believing that these would make the largest impact on its objective.

Growth in the domestic production of oilcake is the best measure by which the PRF can ascertain the extent to which it is achieving its objectives, by way of supporting the industry with research, new technology and technology transfer. For the PRF to continue to emulate the great progress that has been made to date, targets need to be defined, for which projections need to be made of future oilcake demands, what will be required to obtain self-sufficiency, and when this goal is likely to be met.

To measure this progress accurately, various models have been developed and used over the years. Recently, a new model has been developed which considers changes in *per capita* consumption of meat, milk and eggs as projected by BFAP, as well as population growth. The quantity of meat, milk and eggs that are predicted to be imported and exported are also considered. Incorporated into the model are projected future prices and availability of major raw materials, mainly those that are derived as by-products from various agricultural processing industries. The model calculates the quantity of feed required as well as the raw material breakdown for these feeds.

The genetic improvement of animals has a substantial impact on productivity, therefore the change in animal performance is an important factor considered by the model.

There are several animal species, such as dogs and cats, that are not producers of meat, milk and eggs but which nevertheless consume substantial amounts of animal feed, including protein. The feed and protein consumption of these animals also needs to be accounted for.

Making use of least cost linear programming and considering transport costs of raw materials across various regions of the country, the model formulates the actual feed required by all animals in South Africa given the constraint of the quantity of raw materials that are domestically available. The result is an accurate prediction of current and projected protein requirements both domestically and imported.

<u>Results</u>

<u>Current Scenario</u>

Based on the current *per capita* consumption of animal products it is estimated (using the APR Model) that the requirement for animal feed in South Africa is as shown in Table 1:

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

Feed Type	National feed consumption (ton)
Aquaculture	5 125
Broiler	3 326 392
Cattle Beef	2 920 558
Cattle Dairy	2 600 809
Horses	127 310
Layer	1 305 565
Ostriches	88 014
Pets	368 287
Pigs	1 086 174
Sheep	258 888
Various	10
Grand Total	**12 087 124**

Soya oilcake remains the most consumed oilcake in South Africa, followed by sunflower oilcake (Table 2).

Table 2: Oilcake usage for 2021

Oilcake type	National consumption (ton)
Cotton Full Fat	9 000
Soya Full Fat	155 000
Canola Oilcake	74 000
Soya Oilcake	1 444 193
Sunflower Oilcake	381 804
Palm Kernel Meal	5 700
Total	**2 069 697**

On the local market, South Africa progressed in terms of substituting imported soya oilcake with local oilcake. Currently South Africa produces 73 % of the total requirement in 2022, whereas in 2009 this was only 16 % (Table 3). The projection for 2024 is 81 % and will increase to 100 % in 2030. However, the substitution is highly dependent on efficient infrastructure and logistical support, providing internal raw materials to coastal areas at competitive prices. The usage of oilcake is also sensitive in terms of price and competition for raw materials containing protein. For instance, an increase in lucerne production or wet-milled by-products directly affects the usage of oilcakes.

Table 3: Historical usages of soya oilcake (Local and imported soybeans processed in South Africa)

Year	Local soya oilcake (ton)	Total soya oilcake (ton)	Local %
2001	121 140	598 070	20
2002	141 520	616 593	23
2003	120 000	705 352	17
2004	119 280	616 596	19
2005	92 080	740 558	12
2006	210 000	849 678	25
2007	303 280	1 115 280	27
2008	253 200	1 261 791	20
2009	181 600	1 111 172	16
2010	251 840	1 083 640	23
2011	301 600	1 291 069	23
2012	347 760	1 271 341	27
2013	469 360	1 197 978	39
2014	565 280	1 232 687	46
2015	765 287	1 254 120	61
2016	768 800	1 218 001	63
2017	836 285	1 267 098	66
2018	766 795	1 150 521	66
2019	820 000	1 218 000	67
2020	849 700	1 213 700	70
2021	1 073 682	1 444 193	73

In terms of total oilcake, the local share in consumption increased from 34 % in 2009 to 79 % in 2020, and kept constant at 79 % in 2021 (Table 4). It is projected that the local share will increase to 85 % in 2024 and 99,7 % in 2030.

Table 4: Historical usages of Total oilcake (Local and imported oilcake)

Year	Local Oilcake (ton)	Total Oilcake (ton)	Local %
2001	454 192	1 021 862	44
2002	482 448	1 149 224	42
2003	472 312	1 210 396	39
2004	489 413	1 121 460	44
2005	416 736	1 212 593	34
2006	572 231	1 414 338	40
2007	608 370	1 635 525	37
2008	494 557	1 758 185	28
2009	565 181	1 664 927	34
2010	701 030	1 743 137	49
2011	624 912	1 857 391	34
2012	766 927	1 856 360	41
2013	760 321	1 877 671	40
2014	913 356	1 889 979	48
2015	1 197 604	1 914 330	63
2016	1 238 120	1 965 291	63
2017	1 300 865	1 798 372	72
2018	1 441 527	1 649 498	87
2019	1 434 660	1 875 738	76
2020	1 485 183	1 885 663	79
2021	1 643 916	2 069 697	79

To calculate the consumption figures of the different species it is important to determine the demand for their products. This was calculated using the following macro variables in combination with animal feed conversion ratios and growth projections:

- Population growth
- Per Capita consumption growth
- Imported animal products
- Exported animal products

Table 5: Projected feed and oilcake requirements for the year 2024 and 2030

Year	Feed (ton)	Oilcake (ton)	Soya Oilcake (ton)
2021	12 087 124	2 069 697	1 444 193
2024	12 803 849	2 147 953	1 515 659
2030	13 631 093	2 202 461	1 537 560

As explained earlier, soya oilcake remains the dominant protein source in South Africa. This dominance has increased over time and will continue to do so. Future consumption of soya oilcake is highly influenced by feed conversion ratios (FCR), which, if these continue to improve, will stabilise future consumption. However, exports of beef, sheep and the prospect of chicken being exported will increase the consumption of animal feed and will have an impact on the end consumption figures for 2030.

Local Soya Oilcake Production

Conclusion

The prospect of South Africa in the future becoming independent of imported protein for animal feed looks increasingly promising. However, this is dependent on several factors. With increasing efficiencies in FCR, if animal numbers remain the same the demand for animal protein may stabilise, in which case it would be important for the soybean industry to increase demand elsewhere. This additional demand could occur in exports of animal products. Currently this is the focus of the different Masterplans being discussed which, if successful, will play an important role in sustainability. However, the outcome and positive outlook is yet to be seen.

Another factor of importance is the price and competition for raw materials. To sustain the projected local consumption levels, raw material prices tend towards export parity. This implies that much work will be needed to increase the feasibility of producing the raw materials at these levels. Sensitivity is specifically related to the price of protein sources, one of these ratios being the maize to soybean price ratio.

Given the production of raw materials, the question is whether there will be opportunities in the future for exports. Some of the commodities can be exported but there may be better opportunities to export processed product.

The protein raw material basket is complex, and any change in price or availability of one raw material will affect the utilisation of oilcake, specifically soya oilcake. If the production or importation of an alternative protein source increases, this will have a direct impact on the consumption of soya oilcake.

Logistics and biosecurity will play an important role in the future. If inland products cannot be delivered price-competitively to coastal consumers, imports will continue. If the exports of animal products do not increase, due, for example, to biosecurity lapses, there will be pressure on the utilisation of soybean oilcake in South Africa and this will have a direct impact on production.

If all of the above fall into place, South Africa could soon become totally self-sufficient in oilcake production (Table 8) and there may even be some space to increase soyabean production.

Table 8: Projected self-sufficiency in total oilcake and soya oilcake

	2021	2024	2030
Total Oilcake	73 %	85 %	99,7 %
Soya Oilcake	66 %	82 %	100 %

4.5 INCOME AND COST BUDGETS FOR SUMMER AND WINTER CROPS IN SOUTH AFRICA; D van der Westhuizen, The Bureau for Food and Agricultural Policy (BFAP)

Background

The Bureau for Food and Agricultural Policy (BFAP), founded in 2004, serves the agro-food, fibre and beverage sectors in South Africa and Africa. Our purpose is to inform better decision-making by providing unique insights gained through rigorous analyses, supported by credible databases, a combination of integrated models and considerable experience. Over more than 15 years, the Bureau has developed a distinct value proposition to deliver a holistic solution to public sector and private clients active in the agricultural sector and related value chains. This offering is complemented through BFAP's investment in the Integrated Value Information System (IVIS), a geo-spatial platform which further enhances BFAP's product offering by providing enhanced systems-solutions to the integration of data and insights visualisation to support strategic-decision-making along multi-dimensional value chains.

The BFAP Group consist of a team of experienced private and public sector experts with a range of multi-disciplinary skills including agricultural economics, food science, mathematics and data science, engineering, supply chain management, socio-economic impact assessment, systems technology, and geo-informatics. In addition, we fundamentally believe that a competitive and thriving agricultural sector with its related value chains is built on long-run partnerships. Hence, BFAP has developed a well-established network of local and international collaborators and partners in the public and private sector. This includes long-standing partnerships with private sector clients for more than a decade, research partners like the Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri in the USA and the Food and Agricultural Organization of the United Nations (FAO). BFAP is also one of the founding members and partners of the Regional Network of Agricultural Policy Research Institutes (ReNAPRI) in Eastern and Southern Africa. As a team and as a network, we pool our knowledge and experience to offer the best possible insights and access to a unique high value network.

The BFAP Group utilises globally recognised techniques and modelling systems to analyse the food, fibre and beverage sectors.

The current BFAP modelling system covers more than 50 commodities each supported by:

- In-depth study of agro-resources and input-output markets, production systems and farming business operations, offering the ability to evaluate the competitiveness and sustainability of farming systems.
- End-to-end value chains analysis, tracking product flow, efficiencies, and margins along the chain.
- Commodity markets scenario modelling and forecasting to quantify future outcomes, evaluate risk, identify growth opportunities and assess impacts of changes in the macro-economic, business and policy environment.
- Analysis of the consumer and retail space to provide insights on food price impacts and food security
- Credible analysis, monitoring and evaluation of rural and socio-economic development related to the food, fibre and beverage industries

The extensive integrated database and modelling frameworks enable BFAP to analyse and generate long-run projections and unpack alternative future scenarios for agricultural commodity markets and within the main sub-sectors (grains, livestock, and horticulture).

The BFAP Farm & Production Analytics Division

The program

The BFAP Farm & Production Analytics was established with the main objective to assist agribusinesses and farm businesses with strategic decision-making under changing and uncertain market conditions. This is done by means of advanced quantitative analyses of how different policy options, macroeconomic variables, and volatile commodity market conditions could impact upon farm businesses in selected production regions in South Africa.

The BFAP Farm & Production Analytics Division includes economic analysis of the production of grain, oilseed, livestock, wine, fruit, sugar, and vegetables. Proto-type farms across South Africa's key producing regions are constructed according to a standard operating procedure (SOP) defined by the agri benchmark methodology and are presented in the Table 1.

Table 1: BFAP existing network of prototype farms

Table 1: BFAP existing network of prototype farms

Summer Grains	Winter Grains	Oilseeds	Small-scale	Sugarcane	Potatoes	Horticulture	Pig Network
Western Free State: maize	Overberg: Wheat	Eastern Free State: Soybeans	KwaZulu-Natal: Traditional producers	KwaZulu-Natal: Northern Coastal Dryland	Eastern Free State: Dryland	Western Cape: Apples	Western Cape integrated farm
Northern Free State: maize	Overberg: Barley	Eastern Free State: Sunflower	KwaZulu-Natal: Grain Developmen t Program	KwaZulu-Natal: Southern Coastal Dryland	Limpopo: Irrigation	Western Cape: Pears	KwaZulu-Natal integrated farm
Eastern Free State: maize	Northern Cape: Wheat	Northern Free State: Sunflower & Cotton		KwaZulu-Natal: Midlands	KwaZulu-Natal: Seed	Citrus	North West integrated farm
Northern Cape: maize	Northern Cape: Barley	North West: Sunflower & Cotton		Mpumalanga: Irrigation	Sandveld: Irrigation		
Mpumalanga: maize (budgets)	Swartland: Wheat, barley & canola: 2019	Mpumalanga: Soybeans (budgets)		KwaZulu-Natal: Northern Coastal Dryland (small-scale)			
North West: maize		Overberg: Canola					
		Northern Cape: cotton					
		Limpopo: cotton					

The models & methodology

The farm-level activity of BFAP consists of two key components on which services to individual clients are based. These include the system of linked models between the sector and the FinSim farm-level models and the agri benchmark international network.

Farm-level modelling

The BFAP farm-level model (FinSim) is a total budgeting model capable of simulating a (representative) farm comprising various enterprises, e.g., grain, oilseeds, and livestock. Apart from the enterprise specifics, the model captures business specifics, such as the asset structure and financing method(s). The output of the farm-level model is presented through various financial performance indicators. The BFAP FinSim model is utilised in various ways, which include whole-farm planning (capital and operational expenditure), financial and economic feasibility on farm-level, risk analysis via stochastic simulation, impact of policy decisions, input- and market-related shocks on farm-level, and the intermediate and long-term projections based on the BFAP sector output.

Agri benchmark

The agri benchmark network is an international network of agricultural research and advisory economists aiming to create a better understanding of global cash crop farming and the economics thereof. The objective of the agri benchmark initiative is to create a national and international database on farm information through collaboration between the public sector, agribusinesses and producer organisations. The link between the local and international network provides the means to benchmark South African agriculture with worldwide farming systems.

More specifically, the national farm information database that is linked to the international information system provides decision makers and stakeholders in South Africa agriculture with a useful tool top obtain business intelligence information, to obtain updates on local and international agriculture, to make financial and managerial strategies for profitable and sustainable farming, and finally, it provides a platform to compare farming businesses and production systems of 16 cash crop enterprises all over the world. The map below illustrates the major countries and crops in the agri benchmark network.

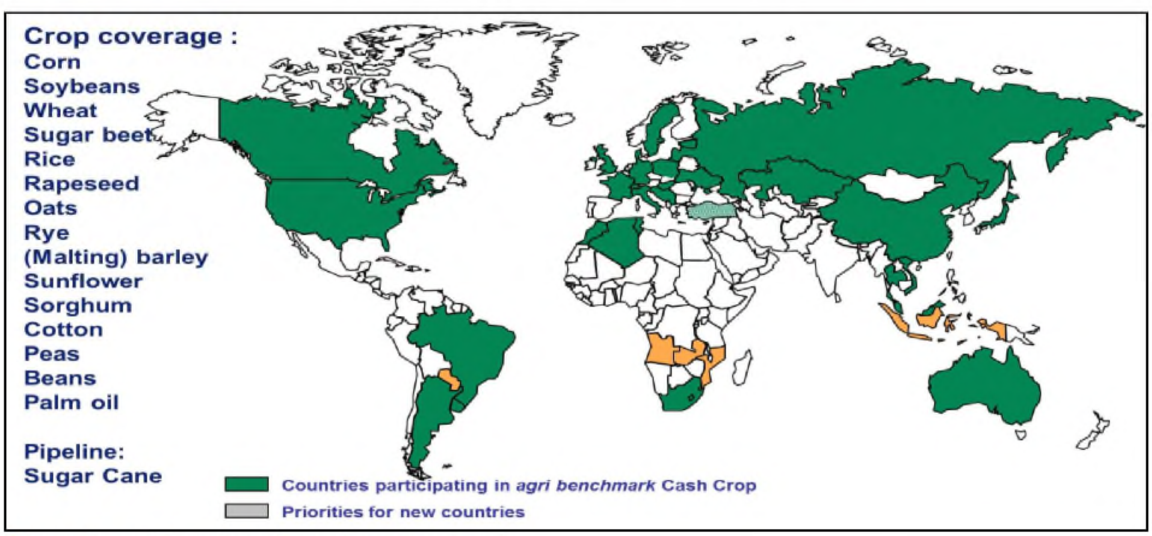

Figure 1: agri benchmark cash crop network

Objectives & key deliverables:

The Protein Research Foundation (PRF), Grain South Africa (GSA) and the Bureau for Food and Agricultural Policy (BFAP) currently have their individual cost of production programs which focusses on the key summer- and winter crops produced in South Africa's key agro-ecological zones. Given the existing activities associated within the organisations and the extent of the coverage of South African agricultural production, it is envisaged that by collaboration and integration of existing activities by PRF, GSA and BFAP will add immense value to the individual organisations' annual output. The main objective is hence to consolidate the three programs, generate comprehensive crop income and cost budgets for the key summer- and winter growing regions and lastly to generate sensitivity analysis for these crops based on the latest macroeconomic trends, BFAP Baseline underlying assumptions and international- & domestic updates. Please refer to annexure of this proposal for detailed regions and proposed crops.

Specific objectives:

- Generate crop income- and cost budgets for key summer grains- and oilseeds in selective regions in South Africa: Dryland: Mpumalanga / Eastern Highveld, Eastern Free State, Northern-and Western Free State, North West and KwaZulu-Natal. Irrigation: Northern Cape, Brits, Limpopo & Bergville.
- Generate crop income- and cost budgets for key winter grains- and oilseeds in selective regions in South Africa: Dryland: Eastern Free State, Southern Cape and Western Cape. Irrigation: Northern Cape, Brits, Limpopo and Bergville.
- Generate sensitivity analysis for the above identified crops based on the latest market trends and projections. The identified regions and proposed crop coverage is presented in the annexure of this proposal.
- Generate a bi-annual report on crop budgets for the subsequent season.

Proposed schedule of reports

- February/March - Planning & analysis for subsequent winter crop;
- August/September - Planning & analysis for subsequent summer crop.

Annexure: Proposed regions & crops covered:

Figures 2-11 illustrate the existing coverage between the GSA and BFAP. It is proposed to continue with the below listed regions and crops covered by GSA and BFAP which will cover and also add to the scope of work and objectives from the PRF. Lastly, the existing needs from the PRF will focus on level 1 of the program: crop budgets updated annually.

Levels definitions:

- Level 1: Commodity enterprise budgets: updated annually;
- Level 2: Actual cost of production (historic);
- Level 3: Projections / Quarterly Updates.

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Summer	Mpumalanga	Eastern Highveld	Maize: Conventional			x	Eastern Highveld: Level 1		
			Maize: Round-up	x	Piet Retief & Trichardt: Level 1	x	Eastern Highveld: Level 1	x	Eastern Highveld: Level 1
			Maize: Stack genes			x	Eastern Highveld: Level 1		
			Maize: BT	x	Piet Retief & Trichardt: Level 1				
			Maize: Irrigation			x	Eastern Highveld: Level 1		
			Soybeans: Conventional	x	Piet Retief & Trichardt: Level 1	x	Eastern Highveld: Level 1	x	Eastern Highveld: Level 1
			Soybeans: Minimum tillage	x	Piet Retief & Trichardt: Level 1	x	Eastern Highveld: Level 1		
			Sunflower	x	Piet Retief & Trichardt: Level 1				
			Sugarcane					x	Mpumalanga Irrigation: Level 1-3

Figure 2: Mpumalanga / Eastern Highveld

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Summer	Free State	Eastern Free State	Maize: Conventional			x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Maize: Round-up			x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Maize: Stack genes			x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Maize: BT	x	Reitz/Petrus Steyn/Bethlehem/ Warden: Level 1	x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Sunflower	x	Reitz/Petrus Steyn/Bethlehem/ Warden: Level 1	x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Soybeans RR	x	Reitz/Petrus Steyn/Bethlehem/ Warden: Level 1	x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Potatoes					x	Eastern Free State: Studygroup averages: Level 1-3

Figure 3: Eastern Free State

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Summer	Free State	Northern Free State	Maize: Conventional			x	Parys region: Level 1		
			Maize: Round-up			x	Parys region: Level 1	x	Bothaville / Wesselsbron: Level 1-3
			Maize: Stack genes			x	Parys region: Level 1		
			Maize: BT			x	Parys region: Level 1	x	Bothaville / Wesselsbron: Level 1-3
			Maize: Irrigation			x	Parys region: Level 1		
			Sunflower			x	Parys region: Level 1	x	Bothaville / Wesselsbron: Level 1-3
			Groundnuts			x	Parys region: Level 1		
			Grain Sorghum			x	Parys region: Level 1		
			Soybeans			x	Parys region: Level 1		
Summer	Free State	Western Free State	Maize: Round-up					x	Bultfontein: Level 1-3
			Maize: BT					x	Bultfontein: Level 1-3
			Maize: Irrigation					x	Bultfontein: Level 1-3

Figure 4: Northern- and western Free State

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Summer	North West	North West	Maize: Conventional	x	Koster Hoëveld & Lichtenburg/Ottosdal/Sannieshof/Delareyville: Level 1	x	North West: Level 1	x	Lichtenburg / Delareyville / Koster / North West prototype: Level 1-3
			Maize: Round-up			x	North West: Level 1	x	Lichtenburg / Delareyville / Koster / North West prototype: Level 1-3
			Maize: Stack genes			x	North West: Level 1		
			Maize: BT			x	North West: Level 1		
			Maize: Irrigation			x	North West: Level 1		
			Sunflower	x	Koster Hoëveld & Lichtenburg/Ottosdal/Sannieshof/Delareyville: Level 1	x	North West: Level 1	x	Lichtenburg / Delareyville / Koster / North West prototype: Level 1-3
			Soybeans	x	Koster Hoëveld & Lichtenburg/Ottosdal/Sannieshof/Delareyville: Level 1	x	North West: Level 1		

Figure 5: North West

Summer	KwaZulu-Natal	KwaZulu-Natal	Maize	x	Bloedrivier: Level 1			x	Northern-Natal: Level 2
			Maize: Irrigation	x	Bergville: Level 1				
			Soybeans	x	Bloedrivier: Level 1			x	Northern-Natal: Level 2
			Soybeans: Irrigation	x	Bergville: Level 1				
			Sugarcane					x	Coastal Dryland & Midlands: Level 1-3
			Potatoes					x	Mooirivier: Level 1-3
			Small-scale maize					x	Bergville: Level 2

Figure 6: KwaZulu-Natal

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Summer	Irrigation 	Northern Cape	Maize	x	GWK region: Level 1	x	Orange River: Level 1	x	Prieska & Douglas: Level 1-3
			Soybeans RR	x	GWK region: Level 1	x	Orange River: Level 1		
			Groundnuts	x	GWK region: Level 1				
		Limpopo / Britz	Maize	x	Loskop & Britz/Koedoeskop/ Makoppa: Level 1	x	Limpopo/Britz: Level 1		
			Soybeans	x	Loskop & Britz/Koedoeskop/ Makoppa: Level 1	x	Limpopo/Britz: Level 1		
			Sorghum			x	Limpopo/Britz: Level 1		
			Sunflower			x	Limpopo/Britz: Level 1		
		Bergville	Maize	x	Bergville: Level 1				
			Soybeans	x	Bergville: Level 1				

Figure 7: Summer Irrigation: Northern Cape, Brits, Limpopo & Bergville

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Winter	Irrigation 	Northern Cape	Wheat	x	GWK region: Level 1	x	Northern Cape: Level 1	x	Prieska & Douglas: Level 1-3
			Barley			x	Northern Cape: Level 1	x	Prieska & Douglas: Level 1-3
			Canola	x	GWK region: Level 1				
		Limpopo / Britz	Wheat	x	Loskop & Britz/Koedoeskop/ Makoppa: Level 1	x	Winter irrigation: Level 1		
			Barley			x	Winter irrigation: Level 1		
		Bergville	Wheat	x	Bergville: Level 1				

Figure 8: Winter Irrigation: Northern Cape, Brits, Limpopo & Bergville

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Winter	Free State 	Eastern Free State	Wheat conventional	x	Reitz/Petrus Steyn/Bethlehem/ Warden	x	Eastern Free State: Level 1	x	Eastern Free State: Studygroup averages: Level 1-3
			Wheat after fallow			x	Eastern Free State: Level 1		
			Irrigation wheat			x	Eastern Free State: Level 1		
		Central Free State	Wheat conventional			x	Central Free State: Level 1		
			Wheat: minimum tillage			x	Central Free State: Level 1		

Figure 9: Free State – Winter

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Winter	Southern Cape	Overberg / Ruens	Wheat conventional			x	Western Ruêns: Level 1		
			Wheat minimum tillage	x	Bredasdorp / Caledon: Level 1	x	Western Ruêns: Level 1	x	Bredasdorp / Caledon: Level 1-3
			Barley	x	Bredasdorp / Caledon: Level 1	x	Western Ruêns: Level 1		
			Canola	x	Bredasdorp / Caledon: Level 1	x	Western Ruêns: Level 1	x	Bredasdorp / Caledon: Level 1-3
			Oats	x	Bredasdorp / Caledon: Level 1	x	Western Ruêns: Level 1	x	Bredasdorp / Caledon: Level 1-3
			Lupines			x	Western Ruêns: Level 1		
			Medics					x	Bredasdorp / Caledon: Level 1-3
			Lucerne					x	Bredasdorp / Caledon: Level 1-3
		Swellendam	Wheat	x	Swellendam: Level 1				
			Barley	x	Swellendam: Level 1				
			Canola	x	Swellendam: Level 1				
			Oats	x	Swellendam: Level 1				

Figure 10: Southern Cape – Winter

				PNS		GSA		BFAP	
CROP CATEGORY	PROVINCE / REGION		CROP TYPE	Coverage	Description	Coverage	Description	Coverage	Description
Winter	Western Cape	Swartland	Wheat conventional			x	Swartland: Level 1		
			Wheat minimum tillage	x	Swartland: Level 1	x	Swartland: Level 1		
			Canola	x	Swartland: Level 1	x	Swartland: Level 1		
			Lupines			x	Swartland: Level 1		

Figure 11: Western Cape – Winter

4.6 RESEARCH ON SOYBEANS TO STUDY NEW PRELIMINARY TREATMENTS WITH DIFFERENT BIOLOGICAL LEAF APPLICATIONS AS WELL AS CHEMICAL APPLICATIONS AND A DEMONSTRATION TRIAL IN A WAGON WHEEL DESIGN; WF van Wyk, Contractor, Protein Research Foundation

2021/2022: Trials conducted on the UP-Experimental farm in Hatfield, Pretoria.

- *Demonstration trial in a wheel design*

Treatments: Four (4) Cultivars from a MG 4 - 7 were used. There were 4 rows of each cultivar and 2 entrances to the middle of the trial were kept clean in order to access the trial. Plant density was kept constant, at 250 000 plants/ha, in half of the trial, while row width in this half varied from 1.5 m at the outside of the circle to 30 cm at the inside. See Fig 1 below.

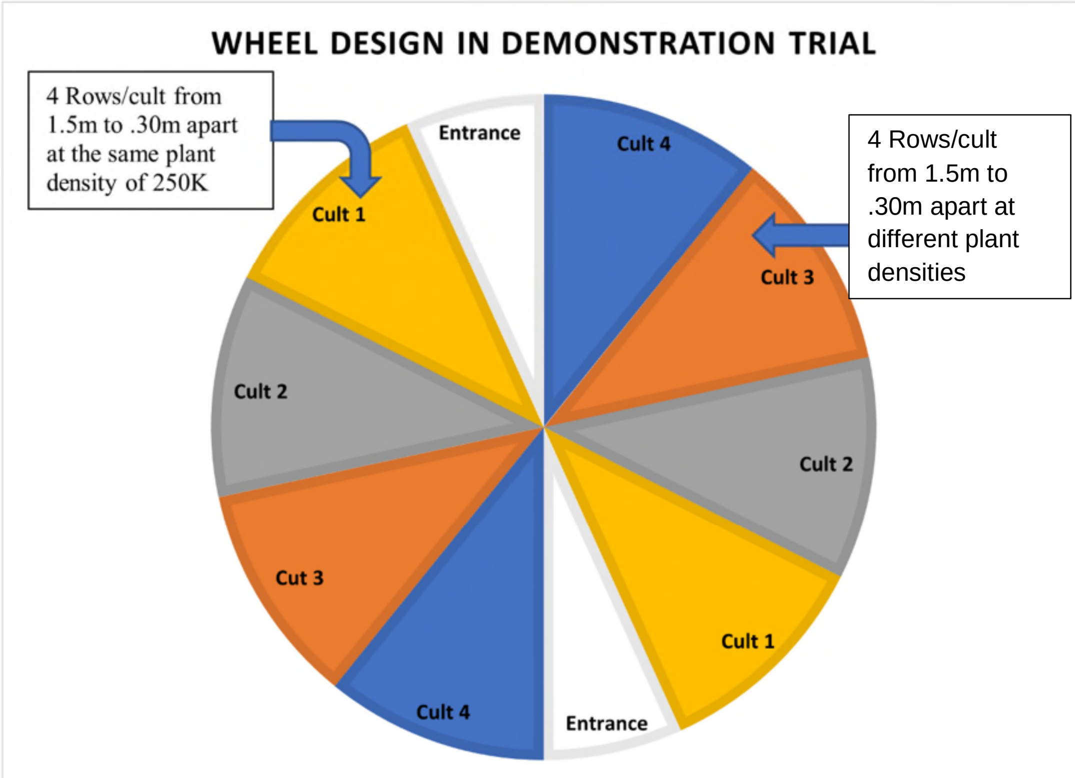

FIG 1. The wheel design which was used to compare different parameters and yield of four cultivars at different row widths and plant densities.

In the other half of the demonstration trial the distance between plants was constant at 8 cm (i.e.12.5 plants per running meter) which resulted in 87 719 plants/ha in 1.425 m rows and 308 025 plants/ha in 0.405 m rows when planted.

Photo 1. Wheel design trial at 5 weeks

Photo 2. Wheel design trial at 15 weeks

The arrangement of the rows can be seen in Photo's 1 and 2 in the wheel design.

In the centre of the 'wheel' a circle with a diameter of 2 meters remained unplanted, enabling access from one side to the other. The rows were 8 m long but only 7 m were harvested resulting in seven treatments. The table below describes these treatments, which are based on the differences in row width for every 1 m distance from the outside to the inside as well as the average row width per meter.

Treatment from outside to inside	Range	Average row width
T1	150 - 135 cm	1.425 m
T2	135 - 115 cm	1.250 m
T3	115 - 104 cm	1.095 m
T4	104 - 85 cm	0.945 m
T5	85 - 71 cm	0.780 m
T6	71 - 51 cm	0.610 m
T7	51 - 30 cm	0.405 m

Soybeans were harvested, threshed and the yield and other data recorded. The aim of this demonstration trial was to establish the correlation between plant density and yield as well as branching and pod height. Plants at harvest were also compared to number of seeds planted in order to find an explanation for the differences that sometimes occur between planting and harvesting. The four cultivars used were C1 = DM 5953 (MG 4.4), C2 = PAN 1521 R (MG 5), C3 = PAN 1644 (MG 6.4) and C4 = DM 6.8i (MG 6.8).

Yield of the MG 4 and 5 cultivars was influenced by the large amount of rain that fell during Nov to Dec, the average yield being around 2.4 ton/ha for MG4 and 2.5 ton/ha for MG5. The best yields, of 4132 kg, 3891 kg and 3703 kg/ha, were achieved with PAN 1644R at plant densities of 224 000, 234 000 and 233 000 plants/ha, respectively. The row widths at these plant densities were 78.6 and 94.5 cm respectively.

The treatment which had the least reduced plant density at harvest was PAN 1644 R in 61 cm rows, where planting density decreased by only 6.55% from the original 250 000 plants/ha to 233 606 plants/ha with a yield of 3891 kg/ha. The treatment which had the most reduced plant density at harvest was DM 5953 in 150 cm rows where planting density decreased by 34% to164 192 plants/ha with a yield of 1333 kg/ha.

On the other side of the wheel, in the wide rows (1.425 m), the harvest plant density of DM 5953 dropped by 20% from planting to harvesting. For the narrow rows (0.405 cm) the drop in density was 40%. The drop in density for the wide and narrow rows for PAN 1521 R, PAN 1644 and DM 6.8i R was respectively 12 and 16%, 20 and 19% and 18 and 25%. The three top yields were achieved using PAN 1521R (4617 kg/ha at 259 259 plants/ha), PAN 1644 R (4123 kg/ha at 249 152 plants/ha) and PAN 1521 R (3801 kg/ha at 131 410 plants/ha).

- *Treatments involving biological leaf applications and/or chemical applications*

- ➢ Application of kraal manure at 20 tons/ha, sheep manure at 15 tons/ha and poultry manure at 12 ton/ha.
- ➢ 25 cm Row spacing with two seeds/position planted every 33.3 cm in the row - giving a density of 240 000 plants/ha.
- ➢ Application of Spoor en Boor on the leaves of soybeans in 45 cm rows at R2 (only micro-elements). CULTIVAR - PAN 1521.
- ➢ Application of product of Rolfes on the leaves of soybeans in 45 cm rows at dosages 0.1 x dosage and 2.0 x dosage on Cultivar PAN 1644 R and application at 1.0 x dosage on Cultivar DM 5953 R.
- ➢ Two controls in 45 cm rows on cultivar DM 5953R and one on cultivars PAN 1644R and on PAN 1521R respectively.
- ➢ Application of LAN at R2 at rates of 0, 200 and 300 kg/ha on DM 5953.
- ➢ Application of Ammonium Sulphate at rates of 0, 100 and 200 kg/ha at R2 on DM 5953R.
- ➢ Application of Brandt Smart Quatro containing Molybdenum, Cobalt, Copper, Magnesium and Boron as foliar on PAN 1521R.
- ➢ Application of Green Liquid (Product of Elim Kunsmis) containing a broad range of macro- and trace-elements, plant stimulating hormones and enzymes and a stimulant for natural soil micro-flora. This application was on PAN 1644R.

The treatments were harvested, threshed and post-harvest data were recorded. The best yield was on Rolfes at double dosage on PAN 1644R with a yield of 5485 kg/ha, second was Brandt Smart Quatro on PAN 1521R with 5263 kg/ha, and third was Rolfes at single dosage on PAN 1644R with a yield of 4833 kg/ha. All the results are to be included in the progress report.

4.8 RESEARCH ON SCLEROTINIA WITH EMPHASIS ON CULTIVATION PRACTICES AND TREATMENT WITH BIOLOGICAL PRODUCTS TO REDUCE ITS OCCURRENCE IN SOYBEAN, Mr WF van Wyk, PRF Contractor

- *Ploughed trial - Mr Piet Prinsloo, Stoffberg.*

  A section of 50 m to 100 m in length and at least 40 m wide was ploughed in a chosen field in August/September at a depth of at least 25 cm. A reversed harrow was used to prepare the seed bed without disturbing the soil. Only the 20 m at the centre of the ploughed field was used for data collection. A similar field, unploughed, served as the control treatment. The cultivar used was DM 6.8i R.

  No sclerotinia infection occurred on the farm and the expectation was that the yields of the ploughed treatment and control would be the same. However, the ploughed treatment outyielded the control by 500 kg/ha (3000 vs. 3500 kg/ha) possibly because of better drainage and lower compaction of the soil on the ploughed treatment.

- *Trial with biological treatment - Wonderfontein*

  A biological treatment (Brandt Smart Quatro) active ingredient *Bacillus methylotrophicus* was used as a foliar application when the first signs of sclerotinia were observed. Two weeks later a second application was used and, although the sclerotinia count was less in the sprayed section, the yield was only 180 kg/ha more than the control at 3124 kg/ha.

4.9 CULTIVAR EVALUATION OF SOYBEANS IN THE WESTERN DRY LAND PRODUCTION AREA OF SOUTH AFRICA; GP De Beer, Contractor, Protein Research Foundation

The past season was certainly the wettest and best soybean seasons the west has ever experienced.

The trials were planted at Migdol, Schweizer Reneke (2 planting dates), Hoopstad, Leeudoringstad and Baberspan (Between Delaryville and Sannieshof).

The trials at Schweizer Reneke were planted on the 5 November and 30 November 2021 using the farmer's planter.

The trial at Leeudoringstad was planted on the 30 November 2021, Hoopstad on the 29 November 2021 and Baberspan on 1 December 2021. These three trials were planted using a new planter belonging to the ARC. This is a Delta Force planter which controls both the down and up forces on the units, with the result that the soybeans are planted more evenly at the same depth.

The trials consisted of 32 cultivars from a MG 4.7 to MG 7.1. All the cultivars in the trials were indeterminate except for LS 6851 R which was determinate. Six new cultivars were included in the trial, namely, P57T19R, RA 5921 R, PAN 1588 R, P62T16R and RA 6520RS.

The trial at Schweizer Reneke (PD 1) had a mean yield of 3233 kg/ha. The cultivar with the highest yield was P64T39 (MG 6.4) with 4073 kg/ha and the cultivar with the lowest yield was DM 5953 RSF (MG 4.8) with 2110 kg/ha.

The second trial at Schweizer Reneke (PD 2) had a mean yield of 1750 kg/ha. This was because the land was waterlogged for the first 7 weeks after planting because of heavy rains. The cultivar with the highest yield was DM 6.8i RR (MG 5.5) with 2493 kg/ha and that with the lowest yield was PAN 1479 R (MG 4.7) with 1065 kg/ha.

The trial at Leeudoringstad had a mean yield of 2491 kg/ha. The cultivar with the highest yield was DM 6.8i RR (MG 6.8) with 4021 kg/ha and the cultivar with the lowest yield was DM 5351 RSF (MG 5.1) with 1111 kg/ha. Yields in this trial were low because of the large amount of rain that fell during the season making the soil waterlogged.

The trial at Hoopstad had a mean yield of 4485 kg/ha. The cultivar with the highest yield was RA 4618 R (MG 4.9) with 5383 kg/ha and the cultivar with the lowest yield was PAN 1588 R (MG 5.9) with 3358 kg/ha. A lot of rain fell during this trial but it was spread more evenly than in the other localities.

4.10 DATA-INTENSIVE FARM MANAGEMENT (DIFM) PROJECT IN SOUTH AFRICA; Ms M Delport, BFAP

Background

Human society has managed to manipulate the nitrogen cycle to great benefit (Christensen, 2004), particularly for food and agricultural systems; but chronic inefficient use of nitrogen fertilizer continues to suppress farm income and degrade the environment. Reliable estimates of what optimal nitrogen application rates and timing might be, and of how these might differ as soil, topology, and weather conditions vary, are largely dependent on labour-intensive techniques, making it financially feasible only to run trials on small plots, at few locations, and for a few years. Reliable estimates of optimal seeding rates face similar challenges.

The past decade has witnessed a revolution in precision farming technology and access to the era of big data. In fact, it is argued that in the next decade agriculture's biggest efficiency gains and improvements will not come from improved seed varieties or advances in mechanisation, but from big data and the analytics and interpretation thereof. Since 2019, BFAP has led the development of a pilot project to introduce Data-Intensive Farm Management (DIFM) in South Africa in collaboration with the University of Illinois, Grain SA, the Protein Research Foundation (PRF) and the University of Pretoria. The DIFM pilot project has been successfully completed in South Africa for three seasons (2019/2020, 2020/2021 and 2021/2022). We believe that the DIFM approach provides a unique opportunity with respect to the application of mechanization technology to generate high-density and high-observation spatial data. Based on research findings during the pilot project and the potential impact that we believe can fundamentally change a wide range of decisions that farmers have to take at farm-level every season, this document puts forward a proposal to continue with the DIFM project by expanding it to further production regions and to repeat the applications over a 3-year period to incorporate a wider spectrum of climatic events.

DIFM presents a research methodology that generates vast quantities of high-quality agronomic field trial data (see Appendix 1 for more details on the methodology). Compared to trials on small plots, where only a few observations can be gathered, the DIFM approach gathers thousands of observations on commercial fields. e.g., in the DIFM pilot in South Africa, more than 2000 observations were gathered on a 57 ha maize field to develop a production function that estimates the relationship between yields, fertilizer applications and seeding rates. Preliminary findings of DIFM trials suggest that on most of the U.S. trial fields, farmers could have improved their financial outcomes by applying both nitrogen fertilizer and seed at lower rates. Preliminary findings from the South African DIFM trials suggest that farmers can improve their financial outcomes by employing site-specific management (as opposed to flat-rate applications). In most cases, higher seeding and fertiliser rate applications could have improved financial outcomes. However, we also need to take into consideration that the pilot study was implanted over the past three years with above-normal rainfall conditions in most of the summer production region. Hence, there is a need to continue with these trials to generate estimates under normal/below normal rainfall conditions.

During the first year of implementing the pilot project in South Africa (2019/20 summer crop season), three trials (2x Maize and 1x Soybeans) were conducted on two farms. During the second year (2020/21 summer crop season), 10 trials (5x Maize and 5x Soybeans) were conducted on five farms. During the third year (2021/22 summer crop season), 10 trials (3x Soybeans, 6x Maize and 1x Popcorn) were conducted on the same five farms, and crop & field combinations were repeated where rotation and farm management practices allowed.

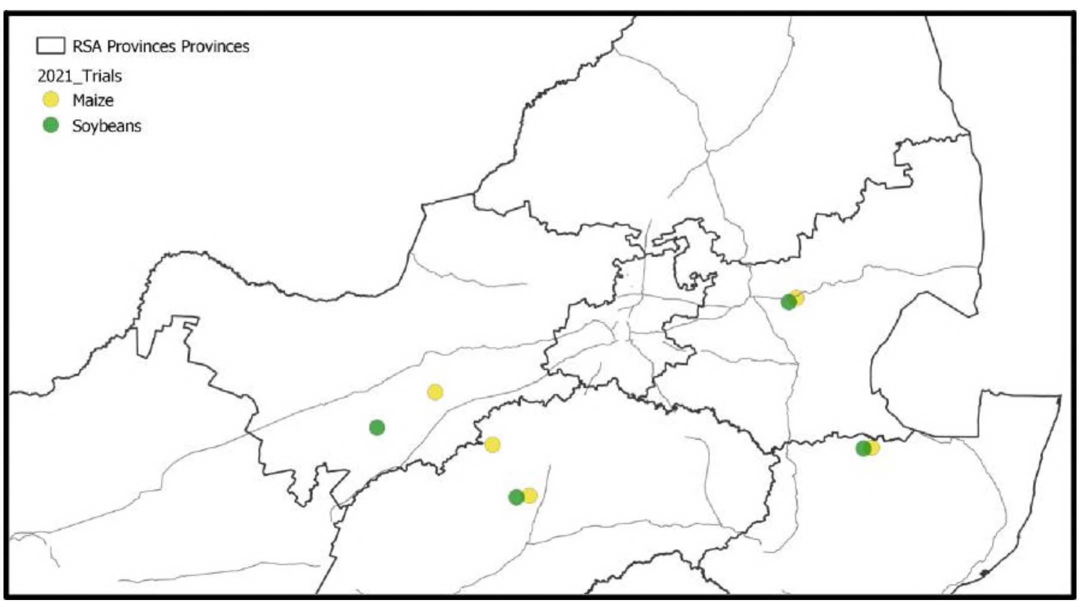

Figure 1: Soybean and maize trial locations

Results Summary

Results from the DIFM pilot phase are presented below.

The maize trial results presented in Table 1 were collated from various farms over the three seasons of the pilot project period. Note, that in most of these locations, the three pilot project seasons were exceptional with rainfall and the timing thereof. They can all be classified as above-average wet, and yielding seasons. This might be a key driver for the recommendations to be quite high. In all the trials it was found that a higher (sometimes the maximum included in the trial treatments) seeding rate and fertilizer rate would be recommended as a profit-maximising flat rate application. With profit differences / impact of between R1692 and R3749 per hectare.

Table 1: Summary of Maize Trial Results

Province	Production region	Planting Date	Seeding rate (plants per ha)		Fertilizer rate (kg/ha)		Profit difference (R/ha)
			Status quo	Optimal	Status quo	Optimal[1]	
Mpumalanga	Wonderfontein	13-11-2019	50 000	60 000	380	380	R3 749
Free State	Henneman	09-12-2019	18 000	28 147	200	239	R1 692
Mpumalanga	Wonderfontein	11-2020	50 000	70 000 (max)	500	600 (max)	
KwaZulu-Natal	Paulpietersburg	04-11-2020	55 000	65 000 (max)	250	380	R2 900
Free State	Henneman	14-11-2020	18 000	26 000	200	282	R3 500
North West	Ottosdal		28 000		*As-applied data could not be retrieved.*		
KwaZulu-Natal	Paulpietersburg	16-10-2021	55 000	80 000 (max)	250	380 (max)	
Free State	Henneman	01-11-2021	18 000	50 000 (max)	200	300 (max)	

[1] Optimal is defined as profit maximizing, given the in-season input and output prices.

Mostly, the soybean trials focus on seeding rate treatments with only a few farmers adding fertilizer variations to the trial. The results vary significantly and in the Wonderfontein and Paulpietersburg cases, multiple profit-optimisation rates are observed from the fitted yield response curve leading to mixed conclusions. The Schweizer-Reneke case is particularly interesting where an average row width of 1.15 m is planted and an optimal seeding rate of 349 780 and 397 000 was recommended. This implies that soybeans are planted in very close proximity within the row - closer than is currently generally recommended by industry. The Bothaville trial underwent some severe water logging during the 2020/2021 season.

Again, one needs to take into account, that these findings are presented for exceptionally wet seasons and that these trials need to be repeated for average and drier conditions as well in order to make recommendations that take some climate risk into account.

Table 2: Summary of soybean trial results

Province	**Production region**	**Planting Date**	**Seeding rate (plants per ha)**		**Fertilizer rate (kg/ha)**	
			Status quo	**Optimal**	**Status quo**	**Optimal[1]**
Mpumalanga	Wonderfontein	26-10-2019	260 000	230 000 / 340 000	NA	NA
KwaZulu-Natal	Paulpietersburg	16-10-2020	285 000	190 000 / 270 000 / 350 000	190	205
Mpumalanga	Wonderfontein	26-10-2020	260 000	340 000	NA	NA
North West	Schweizer- Reneke	12-11-2020	300 000	349 780	NA	NA
Free State	Bothaville	18-11-2020	250 000	150 000 (min)	Urea: 0 Superphosphate: 120	0 (min) 0 (min)
North West	Schweizer- Reneke	23-11-2020	300 000	397 000	NA	NA
Free State	Bothaville	12-11-2021	250 000	380 000	Urea: 0 Superphosphate: 120	20 118 / 200
North West	Schweizer- Reneke	01-12-2021	300 000	200 000 (min)	NA	NA

[1] Optimal is defined as profit maximizing, given the in-season input and output prices.

The analysis for the 2021/2022 trial data was still in progress at the time of writing and can be reported on in a few months' time.

Research outputs to date

- The results from the 2020 analysis were presented at the INFER[1] Symposium on Agri-Tech Economics for Sustainable Futures in October 2020 and published in conference proceedings (see Appendix 3).
- Draft paper to be submitted to the International DIFM conference in Miami, January 2022, and to be submitted to a suitable international peer-reviewed journal.

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

This year was mainly uneventful in terms of major backend updates, and the focus was on keeping existing and new website content up to date. On 28 February 2022, the Protein Research Foundation website hosted a total of 1,258 HTML pages (excluding dynamically created pages).

POPIA

South Africa's POPI Act (Protection of Personal Information Act) came into effect on 1 July 2021 and the Privacy and Cookie Policies were reviewed in March 2021 to ensure that these are compliant. Visitors to the Protein Research Foundation's website are encouraged to read through the policies to see what personal information is collected, how it is used and how it is protected.

ICB Calculator App

During 2021/2022 the online browser web app received approx. 120 launch requests and the Google Play Store statistics show approximately 16 active installations. *(The number of downloads the desktop received cannot be calculated at this stage)*

PHP 7.4 to PHP 8.0

In anticipation of the major PHP** version upgrade scheduled for October 2022 and due to the volume of the content on the PRF's website, we have already initiated validation of the website framework and content.

*** PHP is the base programming language that is used to output website content to the browser. It is also used to process data stored in the MySQL database in order to create and display the dynamic content in the Crops, Research, Bursaries and Snippets sections.*

Website Visitor statistics

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	45078	3.60
2016	31 674	8 733	53 811	4.47
2017	47 373	6 901	20 514	2.18
2018	38 049	10 041	24 873	1.90
2019	45 787	10 444	23 628	1.78
2020	27 317	9 632	24 169	1.93
2021	**25 905**	**12,096**	**24 176**	**1.66**

Google values show an increase in page views and an increase in unique visitors. Pages per visit decreased slightly. The most page views came from the following pages in order of percentage share:

(a) Home page: 13.4%

(b) Soy oilcake price average: 3.13%

(c) Canola Snippets: 2.16%

(d) Soybean Snippets 2.08%

(e) Cassava Characteristics 2.04%

YouTube visitor statistics

Reporting Year	YouTube statistics		
	Views	*Watch time (hours)*	*Subscriber gain*
2014	611	28	+2
2015	1 900	74	+4
2016	8 400	256	+21
2017	23 000	568	+78
2018	35 000	716	+195
2019	27 900	660	+151
2020	27 600	670	+163
2021	**19 400**	**570**	**+161**

The Protein Research Foundation's YouTube channel has grown to almost 858 subscribers by the end of 2021.

5. STUDY GRANTS AND BURSARIES

The PRF bursary scheme was approved in 1994 and the first bursary for postgraduate studies was awarded for the 1995 academic year. We are proud to look back on a period of 24 years during which 78 bursaries were awarded to deserving candidates for Masters' and Doctorate studies. The aim of the bursary scheme is to train deserving candidates in the scientific method 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 their research results in scientific journals, popular magazines or both. Management summaries of theses and manuscripts are published on the PRF website and database.

Bursaries for Masters' studies are awarded for a period of two years and three years in the case of Doctorate studies. Bursaries awarded for the current year were approved by the Technology Committee and were the following:

5.1 MSc Studies

5.1.1 **Mr M Liebenberg** (Second application). 'Feedlot performance and rumen fermentation characteristics of feedlot cattle as affected by dietary protein quality and rumenally protected lysine and methionine supplementation', University of Pretoria.

5.2 PhD Studies

5.2.1 **Ms IR Crouse** (Third application). 'Die ontwikkeling van stikstof bestuurstrategieë vir canola (*Brassica napus*) onder bewaringslandbou-praktyke in die Wes-Kaap', University of Stellenbosch.

5.3 Completed theses received

During the year under review the following thesis was received from a bursary recipient who had successfully completed her studies.

5.3.1 **Ms L Jordaan,** 'The effect of extrusion with molasses and addition of chitosan or tannins on the rumen undegradable protein fraction of plant protein sources', MSc, Stellenbosch University.

6. ACHIEVEMENT AWARDS TO PROMOTE THE PRF VISION AND MISSION

Each year the PRF recognises individuals for their special contributions in support of the vision and mission of the PRF.

Awards are categorised as follows:

- Best Doctoral thesis;
- Best Masters thesis;
- Best article published in a scientific journal;
- An individual or organisation that has made an exceptional contribution in promoting the vision and mission of the PRF; and
- A Board Member who has contributed significantly in promoting, over a period of time, the activities of the PRF.

During the year under review, awards will be presented to Ms Marlese Meiring in the category Best Masters thesis. The award will be presented at an appropriate event during the year under review.

No other awards were made during the year.

7. CONCLUSION

It is with true gratitude that the PRF presents this research report. The results achieved fall within the requirements and objectives set by the PRF. This requires recognition of a large number of institutions and individuals.

The success is based on the hard work and dedication of PRF Board Members and staff, but definitely also the work done by co-workers and contractors. We also express unqualified appreciation to local and international co-workers, researchers and institutions, the press, fund managers, auditors, lawyers and web masters. We trust that this co-operation will continue in the New Year and over many years to come leading to far-reaching and ever greater achievements.

ANDRIES P THERON
CHAIRPERSON

ANNEXURES

I LIST OF APPROVED PROJECTS IN 2020-2021

Latest approved new and continued research projects (proteinresearch.net)

II PRF STRUCTURES

https://www.proteinresearch.net/index.php?page=about-us

III LIST OF BURSARY APPLICATIONS: 1995 - 2021

Bursaries awarded since 1995 (proteinresearch.net)

IV LIST OF RESEARCH PROJECTS: 1976 - 2021

Research projects since 1976-2021