

**ANALYSIS PROCEDURE AND EVALUATION NORMS FOR THE
RELEASE OF BREAD WHEAT BREEDERS' LINES FOR THE RSA**

April 2019 Revision

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INTRODUCTION

The release of bread wheat cultivars is an attempt to provide the wheat industry with new cultivars that perform well agronomically and possess suitable milling, rheological and baking characteristics.

Analytical procedures and release norms are compiled in conjunction with wheat breeders, millers, and bakers to ensure market-directed and quality-driven wheat production in the interest of wheat producers and processors.

Release norms use cultivars as biological quality standards to provide a frame of reference against which new breeding lines are evaluated. Only cultivars that are successfully grown commercially and possess acceptable agronomical and quality characteristics may be considered as biological quality standards.

As the breeding of wheat with the suitable quality characteristics is a long-term project, release norms and quality standards are provided to breeders to provide them with guidelines that should stand the test of time. Changing the release norms and establishing new quality standards are for this reason thoroughly investigated and carefully considered to ensure that the long-term goals of breeding programs are achieved.

1. WHEAT GRADING SYSTEM

The latest regulation with regards to the Grading, Packing and Marking of Bread Wheat intended for sale in the Republic of South Africa was published in the Government Gazette on the 29th of January 2016 (Government Notice No. R. 64).

Provision is made for two classes – Bread Wheat and Other Wheat.

The grades for Bread Wheat are Grade 1, Grade 2, Grade 3, Grade 4 and Utility grade.

No grades are determined for Class Other Wheat.

2. CULTIVARS AS BIOLOGICAL STANDARDS

The effect of the climate, rainfall, environmental interaction, cultivation practices and other factors on wheat quality makes the use of fixed criteria or norms for release purposes impractical.

For this reason, cultivars are used as biological quality standards and acceptable deviations from the standard are established as release norms. It is important that the agronomical performance and yield potential of the chosen quality standard is comparable with those of the breeders' lines, as lower yields in some quality standards are often connected to higher protein content. Large differences in the protein content of breeders' lines and the quality standard cause deviations, especially in rheological analysis results, which complicates the interpretation and evaluation of breeders' lines.

The following cultivars represent the quality standards against which wheat breeders' lines are evaluated:

Dry land Northern (Summer rainfall) areas: Elands

Dry land Southern (Winter rainfall) areas: SST 027*

Irrigation areas:

SST 806

*Notice was given in 2017 by Sensako that seed for SST 027 will no longer be commercially available and that an alternative cultivar should be identified to replace SST 027 as biological standard in the dry land Southern production areas.

2.1 CRITERIA AND PROCESS FOR SELECTION OF A NEW BIOLOGICAL QUALITY STANDARD FOR A SPECIFIC PRODUCTION AREA

When a cultivar selected as biological quality standard for a specific production area is no longer available for commercial planting or when the cultivar's quality is no longer acceptable or suitable, a new quality standard has to be selected. Wheat Breeding companies and/or industry can propose an existing cultivar to be evaluated as quality standard.

The cultivar first and foremost has to comply with the criteria already mentioned.

Additional quality data of a minimum of two (2) years' from at least five (5) localities per annum is required for consideration as quality standard. The samples are to be submitted to the SAGL for analysis as per the list of tests in the quality guidelines (Section 4). The cost for these analyses is to be invoiced to the Wheat Forum (*Resolutions under point 9.2 Selection of New Standard Cultivars for Cape & Winter Rainfall Regions of the minutes of the Wheat Forum Cultivar and Technical Committee meeting held on 19 April 2018*).

3. BACKCROSSES AND HYBRIDS

Backcross parents are not accepted as quality standards. The most important reasons for this are that the backcross parent may not have the desired quality characteristics on the one hand, and on the other the number of backcrosses and selection pressure may result in the original quality not being regained.

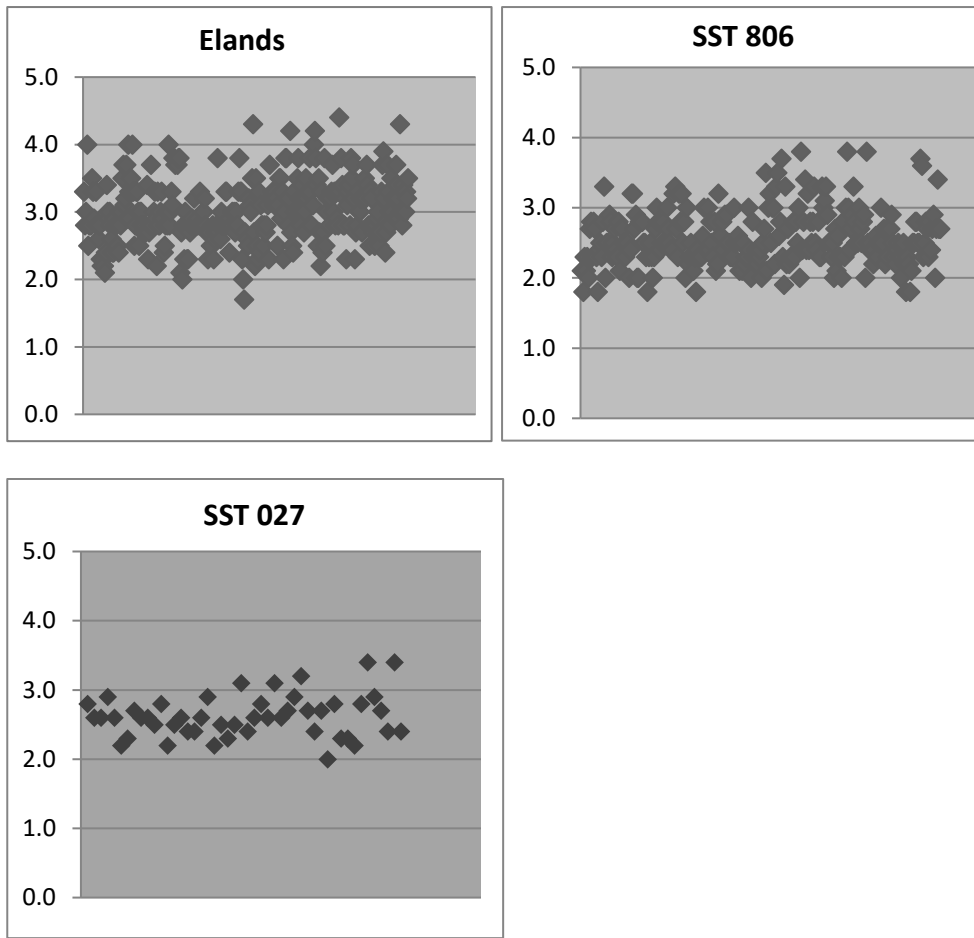
The evaluation process in the case of backcrosses and hybrids is the same as for ordinary cultivars.

4. GUIDELINES FOR ACCEPTABLE DEVIATIONS

4.1 GUIDELINES FOR ACCEPTABLE DEVIATIONS FROM THE STANDARD FOR BREAD WHEAT LINES

The quality norms for release are categorized in primary (P) and secondary (S) quality norms. The quality of new lines is judged by the primary criteria which is non-negotiable. In borderline cases a decisive answer is obtained by referring to secondary norms. Only red cultivars with medium hard to hard morphological characteristics will be allowed in the class.

TEST	CATEGORY	DEVIATION
HLM, kg/hl (clean)	P	-1.8 units
1000 kernel mass, g	S	± 4g
*1 Falling number, sec.	P	- 15%
Protein (12 % mb)	P	- 1%
Extraction, %	P	- 1.5%



Guidelines and acceptable deviations from the quality standard in respect of the mixograph peak times are therefore set as follows:

CULTIVAR TOLERANCE IN RESPECT OF MIXOGRAPH PEAK TIME

ELANDS	+ 15% to - 25%
SST 806	+ 35% to - 10%
SST 027	+ 35% to - 10%

*4 Bread volume is evaluated against the protein level of the line. A factor of 40 cm³ per 1% protein difference is used to adjust the bread volume of the line against the standard. E.g. If a line has a protein content of 11.0% and the standard has a protein content of 12.0%, 40 cm³ will be added to the line's bread volume and vice versa. The current salt (NaCl) level used in the standard 100 g bread recipe is 1.5%.

Key for the evaluation characteristic of the 100 g Baking test:

- 0 – Excellent
- 1 – Very Good
- 2 – Good
- 3 – Questionable
- 4 – Poor
- 5 – Very Poor
- 6 – Extremely Poor

This 100 g baking test evaluation does not provide an indication of the baking quality of the flour per se, but refers to the relationship between the protein content and the bread volume.

EXTENSIGRAPH

In cases where supplementary information is needed, Extensigraph data can be requested.

KONICA MINOLTA COLOUR RESULTS

The Konica Minolta Spectrophotometer CM-5 (instrument settings for 10° observer and D65 illuminant) colour analysis has been included in the quality analyses since the 2013/2014 season.

Colour coordinates reported:

L* measures lightness and varies from 100 for perfect white to zero for black

a* represents green to red variation

b* represents blue to yellow variation

No evaluation criteria for this analysis have been established yet.

4.2 GUIDELINES FOR ACCEPTABLE DEVIATIONS FROM THE STANDARD FOR *HIGH-YIELDING BREAD WHEAT LINES*

During a special meeting of the Research Technical Committee for Wheat of the Winter Cereal Trust held on 15 January 2016, a set of proposed amendments that needs be made to the criteria currently set for the release of bread wheat lines was discussed. There was consensus among all the role players present at the meeting that if the minimum and maximum values of the criteria used to release bread wheat lines are widened to accommodate higher-yielding lines, the yield gain of such lines must be significant. The committee decided that all such lines must yield **at least 5% more** than current commercial bread wheat cultivars.

The relaxed wheat cultivar release criteria for high-yielding lines was thus adopted into this document (*Resolution under point 9.1 Relaxed Wheat Cultivar Release Criteria of the minutes of the Wheat Forum Cultivar and Technical Committee meeting held on 19 April 2018*).

Please refer to **ANNEXURE A** – Yield determination protocol for high yielding lines.

TEST	CATEGORY	DEVIATION
Yield, t/ha	P	+ 5%
HLM, kg/hl (clean)	P	-2.0 units
1000 kernel mass, g	S	± 4g
*1 Falling number, sec.	P	- 15%
Protein (12% mb)	P	- 2.5%
Extraction, %	P	- 2.0%
Break flour yield, %	S	± 5%
*2 Kent Jones Colour (C76), KJ	P	+ 1.5 units
MIXOGRAPH		
*3 Peak time, min.	P	
ELANDS		+ 15% to - 25%
SST 806		+ 35% to - 10%

SST 027		+ 50% to - 5%
FARINOGRAPH		
Absorption (14% mb), %	P	± 3.0%
Development time, min.	S	± 25%
Stability, min.	S	+ 10% to - 30%
ALVEOGRAPH		
Strength, cm ²	P	± 20%
Stability, mm	S	± 20%
Distensibility, mm	S	± 20%
P/L value	P	+ 40% to -25% (Southern areas)
P/L value	P	+ 30% to -25% (Other areas)
BAKING TEST 100g		
*4 Corrected volume, cm ³	P	- 20%
Dough characteristics	P	None (Normal only)

See notes under Section 4.1

5. ANALYSIS REQUIREMENTS FOR FIRST YEAR, PROVISIONAL AND FINAL RELEASE

The analyses required for first year, provisional and final release are conducted by the Southern African Grain Laboratory (SAGL).

Provisional and final release analysis consist of hectolitre mass (HLM), thousand kernel mass (TKM), vitreous kernels (VK), falling number (FN) on whole wheat flour (WW), milling on a Bühler MLU 202 mill reporting break flour yield (BFY) and extraction (EX) values, colour (Kent Jones (KJ) and Konica Minolta (L*a*b*)), protein on WW and flour (FL) as well as mixograph, farinograph, alveograph, consistograph and 100g baking test analyses.

First year release analysis consists of all the above except TKM and consistograph analyses.

Cultivars that passed the evaluation process as described in the most recent version of '*Analysis Procedure and Evaluation Norms for the Release of Bread Wheat Breeders' lines for the RSA*', will be listed on the Wheat Forum Cultivar List as published on the SAGL website. Please refer to Annexures B and C.

5.1 Dry land Northern and Southern production regions

A minimum of two (2) years' analysed data from at least five (5) localities per annum is required for provisional release. If there is any doubt about any of the quality aspects, provisional release is postponed.

For final release, three (3) years' data from a minimum of five (5) localities per annum is required.

If doubt or concerns exist with regards to any of the quality aspects of a line, a fourth year's data can be requested by the Committee.

5.2 IRRIGATION PRODUCTION REGIONS

One (1) year's analysed data from at least five (5) localities is required for provisional release. These samples will be indicated as 'First year Provisional' for unique identification purposes.

If there is any doubt about any of the quality aspects, provisional release is postponed.

For final release, two (2) years' data from a minimum of five (5) localities per annum is required. These samples will be indicated as 'Second year Final' for unique identification purposes.

The analysis conducted on the First year Provisional - and Second year Final samples, will be the same as for Provisional and Final release, mentioned under point 5 on page 7.

If doubt or concerns exist with regards to any of the quality aspects of a line, a third year's data can be requested by the Committee.

Implementation of this criteria will commence in the 2018/2019 production season.

Refer to Resolutions under point 9.2 Classification of Cultivars for Irrigation Areas of the minutes of the Wheat Forum Cultivar and Technical Committee meeting held on 19 April 2018.

5.3 RELEASE OF CULTIVARS in an area other than originally RELEASED

For release in an area other than originally released, a minimum of two (2) years' data from at least five (5) localities is required. The first year's data is valid for provisional release and the second year's data for final release.

If doubt or concerns exist with regards to any of the quality aspects of a line, a third year's data can be requested by the Committee.

6. GENERAL GUIDELINES FOR SUBMISSION OF BREEDERS' SAMPLES TO SAGL FOR ANALYSIS

6.1 DISPATCHMENT OF SAMPLES

6.1.1 Samples may be forwarded by courier or hand delivered to the SAGL's premises.

6.1.2 The cover letter accompanying the samples should contain the following information:

- Breeder company name
- Name and contact information (telephone number and e-mail address) of the person(s) submitting the samples
- Name and contact information (E-mail -, postal - and physical address) of the person(s) to receive the quality analysis report
- Production region / type e.g. winter rainfall, winter dryland, irrigation, etc.
- Samples submitted for first year, provisional or final release
- Clearly indicate lines that should be evaluated against the relaxed release criteria for high-yielding lines
- The name of the biological standard cultivar included
- A list of the names of the breeder lines to be analysed
- A list of the names of the localities where the samples were planted

- 6.1.3 A copy of the appropriate cover letter should be placed in each bag of the consignment.
- 6.1.4 Each sample bag should be clearly marked with the breeder line name, sample code (if applicable) and locality.
- 6.1.5 Breeder line names should be the same throughout from the first year to the final year of analysis to ensure traceability.

6.2 SAMPLE CRITERIA

- 6.2.1 Minimum sample mass for first year analysis is 2.5 kg. Minimum sample mass for provisional (second year) and final (third year) analysis is 3.0 kg.
- 6.2.2 Samples should be treated against insects before dispatch.
- 6.2.3 Samples should be free from soil and grit.
- 6.2.4 When the protein content is less than 10.0% or more than 15.0% (12% mb) evaluation becomes unreliable.
- 6.2.5 The hectolitre mass should not be less than 75 kg/hl (cleaned).

7. REPORTING FORMAT OF QUALITY RESULTS

- 7.1 All quality results generated by the SAGL laboratories, are captured in an Access data base.
- 7.2 The quality results (according to the analyses listed in Section 4.1) per specific breeder line are reported in an Excel file format. A computer program was custom designed for this purpose with the assistance of the SAGL.
- 7.3 Each season's results are summarized on a separate worksheet in the file.
- 7.4 On each worksheet, the biological standard cultivar's quality results are compared to that of the breeder line.
- 7.5 The average, standard deviation and Coefficient of Variance (CV) of both the standard cultivar and breeder line's results over localities are calculated for each quality parameter.
- 7.6 The deviation of the breeder line's average value per parameter, compared to that of the standard cultivar, is calculated and reported.
- 7.7 Deviations exceeding the values indicated under Section 4, Guidelines for acceptable deviations, are flagged.
- 7.8 CV values exceeding the generally accepted maximum value of 15%, are also flagged.
- 7.9 A summary sheet, where the average values of the standard cultivar and breeder line over seasons are compared, is also included.

- 7.10 The summaries as well as the rheological graphs (mixogram, farinogram and alveogram) are forwarded to the breeder company.
- 7.11 An added advantage of the data being summarized in a user-friendly format is that the results of all seed breeders are reported in the same format which facilitates the interpretation and evaluation of the data.
- 7.12 A summary of yield increase calculations for high yielding lines is to be included in the quality results forwarded to the members of the Wheat Forum Cultivar and Technical Committee for evaluation purposes.

8. PRE-MEETINGS FOR DISCUSSION OF RESULTS

Pre-meetings to discuss quality results obtained, are held annually at the end of March/beginning of April. These pre-meetings afford seed breeders the opportunity to discuss their results with representatives of the Milling and Baking industries, prior to the Wheat Forum Cultivar and Technical Committee meeting which is held toward the middle of April each year. These meetings do not have any decision-making powers.

The pre-meetings are open for attendance by any of the members of the Wheat Forum Cultivar and Technical Committee and are chaired by an independent and objective expert. The current appointed Chair is Prof. Marena Manley from the University of Stellenbosch, while Prof. Maryke Labuschagne from the University of the Free State, was appointed as her second. Travel expenses for the Chair to attend the pre-meeting as well as the Wheat Forum Cultivar and Technical Committee meeting are paid for by the Wheat Forum.

Separate meetings, to ensure confidentiality of Intellectual Property, are scheduled with breeding companies on the same day. Currently meetings are held with ARC Small Grain, Pannar and Sensako. These meetings are organized by the SAGL.

A table summarizing the recommendations made during these meetings, are communicated to the Wheat Forum Cultivar and Technical Committee by the Chair of the pre-meetings.

9. CULTIVAR DESCRIPTION

Important grain characteristics that should be noted for the release of a new cultivar are:

9.1 VISUAL KERNEL CHARACTERISTICS

Visual general kernel characteristics such as colour, size, shoulder, back, base, cheeks, skin, groove, germ and beard characteristics are described. Deviating kernels (kernels that look different from the normal shapes of the cultivar) are picked out by hand for a 25 g sample and the percentage is determined.

Dr. Sierk Ybema, an independent industry consultant, is contracted to perform the description of the kernel characteristics as well as identification of deviating kernels.

9.2 Electrophoretic band patterns

Electrophoretic band patterns are determined by means of SDS-PAGE electrophoresis analysis. High molecular weight - glutenin subunits (HMW-GS) are encoded by genes at loci, Glu-A1, Glu-B1 and Glu-D1, and are not reliable for variety identification as many cultivars have the exact same HMW band pattern; however, it is reliable to use to determine seed purity and can be an indication of the homozygous state of a line. The determination is done on 20 kernels.

The Department of Plant Sciences (Plant Breeding) (Faculty: Natural and Agricultural Sciences) of the University of the Free state is contracted to perform SDS-PAGE analyses.

9.3 REPORTING OF GRAIN CHARACTERISTIC RESULTS

Results, as reported by the above-mentioned (points 9.1 and 9.2), are provided to the members of the Wheat Forum Cultivar and Technical Committee meeting by the SAGL. Individual results are forwarded to breeding companies. Result reports are also forwarded to the administrator of the Wheat Forum for minuting purposes.

9.4 CULTIVAR PURITY

All lines approved for final release by the Wheat Forum Cultivar and Technical Committee, are still subjected to strict norms for cultivar purity (maximum 1% impurity) in terms of the provisions for seed standards and certification under the Plant Improvement Act. Cultivar purity under these norms are however only determined after final release.

9.5 DArT ANALYSIS

To improve the current system for determining seed purity (refer to points 9.1 and 9.2), Diversity Arrays Technology Pty Ltd (DArT PL), based at the University of Canberra in Australia, offers an affordable genome profiling option for any organism based on disruptive technology. Diversity Arrays Technology (DArT) analyses, can be used to distinguish between existing cultivars and to confirm the uniqueness of possible new cultivars. CenGen Pty Ltd, based in Worcester in the Western Cape Province, can be contracted to prepare/extract and ship the DNA samples, which will have a significant time savings effect.

10. GENERAL RULES

Any cultivar that is released should in the first instance be of such quality that it could satisfy the local market if it is grown as the dominant cultivar.

Its relative commercial value should be comparable to grain that is available on the world market.

No Genetically Modified (GM) wheat shall be submitted for release prior to notification and consent of the whole industry.

11. TIMELINE FOR THE SUBMISSION OF FUNDING FOR WHEAT BREEDER QUALITY ANALYSES TO THE WINTER CEREAL TRUST AND SUBMISSION OF SAMPLES TO THE SAGL

Funding for quality analysis on first year, provisional and final year release analyses to be performed by the SAGL, can be applied for from the Winter Cereal Trust. Funding applications by breeders for seed analyses should not be submitted to the Winter Cereal Trust individually, but be provided to the SAGL before the end of June every year and will form part of a consolidated application to the Trust by end of July.

Samples of lines to be submitted for provisional or final release of which the results are to be evaluated during the Wheat Forum Cultivar and Technical Committee meeting held during the first half of April each year, are submitted to the SAGL from the middle December to the end of February each year. Adherence to this sample submission timeline is crucial to ensure sufficient time for completion of quality analysis, preparation of result reports and evaluation of the data by representatives of the processing industry, prior to the pre-meetings for discussion of results (referred to under point 8).

Samples of lines for first year analysis are submitted during the above-mentioned time period as well, but may also be submitted later during the year.

12. PUBLICATION, MAINTENANCE AND REVISION OF DOCUMENTATION

The Wheat Forum Steering Committee requested the SAGL to –

- Publish on its website the agreed Analysis Procedure and Evaluation Norms for the Release of Bread Wheat Breeders' lines for the RSA, as well as the Wheat Forum Cultivar List.
- Maintain and update the agreed Analysis Procedure and Evaluation Norms for the Release of Bread Wheat Breeders' lines for the RSA and Wheat Forum Cultivar List in future, subject to the finalization of the necessary protocols.

SAGL was appointed as responsible party for the maintenance of the Analysis Procedure and Evaluation Norms for the Release of Bread Wheat Breeders' lines for the RSA document as well as the Wheat Forum Cultivar List during the Wheat Forum Cultivar and Technical Committee meeting held in April 2018.

The Analysis Procedure and Evaluation Norms for the Release of Bread Wheat Breeders' lines for the RSA document as well as the Wheat Forum Cultivar List are to be revised during the Wheat Forum Cultivar and Technical Committee meeting in April each year and an updated version of the document and/or list published on the SAGL website (if applicable) directly thereafter.

Please refer to:

ANNEXURE B - Protocol for updating the Wheat Forum Cultivar List

ANNEXURE C – Wheat Forum Cultivar list

This document was revised and accepted by members of the Wheat Forum Cultivar and Technical Committee, (Resolution point 6 (1) of the minutes of the Wheat Forum Cultivar and Technical Committee meeting held on 11 April 2019).

Annexure A – Yield determination protocol for high-yielding lines

Background:

During a special meeting of the Research Technical Committee for Wheat, held on 15 January 2016, a set of proposed amendments to the criteria currently set for release of bread wheat lines, was discussed.

During the discussion, the following points were noted, namely:

- The protein content of wheat is a critical quality factor as it would have an impact on all other quality characteristics;
- Breeders had different opinions as to which of the quality characteristics could hamper yield;
- It was necessary to investigate what the effect of relaxing the criteria would be on bringing about an increase in the yield;
- It would be necessary to look at biological standards for high yielding cultivars;
- Trials to identify high-yielding cultivars had to be planted and evaluated independently;
- The environment determined the level of “actual” yield in comparison with “potential” yield;
- Relaxing the quality criteria without an increase in yield would not address producers’ needs; and
- The grading regulations for bread wheat only refer to “red” wheat cultivars.

There was consensus among all the role players present at the meeting that if the minimum and maximum values of the criteria used to release bread wheat lines are widened to accommodate higher-yielding cultivars, then the yield of such cultivars must be significant. The committee decided that all lines proposed as high-yielding cultivars must yield at least 5% more than current commercial bread wheat cultivars.

In order to quantify and standardize the yield determination of high-yield lines a decision was taken that the breeders of the current (i.e. 2016) active breeding companies in South Africa (Sensako, Pannar and Small Grain Institute) need to jointly develop a protocol for determining the yield levels of high-yielding lines.

This protocol was developed at a workshop held on the 11th of February 2016, after the National Cultivar Evaluation Programme (NCEP) meeting.

A proposed protocol for yield determination regarding higher-yielding lines

In order to set a benchmark for newly identified higher-yielding lines, it is important to determine the top three (3) high-yielding commercial cultivars in each of the wheat producing areas in South Africa over the last three years. These top three (3) cultivars will be determined on an annual basis. Once acceptable higher-yielding lines have been identified, released and commercialised, the protocol needs to be reviewed again to determine if these cultivars will be then used as standards and what the significant percentage yield increase of new lines must be in order to be considered for release.

Yield data for higher-yielding lines must originate from replicated trials. A minimum Coefficient of Variance (CV) percentage must be used as a benchmark in order to determine if a trial can be included in the combined yield analysis. Only trials with a CV lower than 10% can be included for the irrigation areas. For the dry land areas, only trials with a CV lower than 15% can be used. The samples from the five (5) trial sites that are submitted to the SAGL for quality evaluation must be used in the statistical analysis to determine the yield level of the lines. The biological standard must also be part of the statistical analysis. The yield performance of the lines considered for release, must be 5% significantly higher than the average of the three (3) pre-determined commercial cultivars.

The statistical trial layout should preferably be a lattice design. When analysing the data, the Least Significant Difference level must be set at 95%.

Cultivars used as standards

The cultivars used as standards, as listed in the table below, must be determined on an annual basis, after the National Cultivar Evaluation Program (NCEP) meeting held in February every year at the ARC-SG in Bethlehem. The current (2018) standards to be used for each production area are summarized in the following table:

Production area	Current Quality Standard	Cultivars
Winter Rainfall Area	SST027	SST015, SST087, SST056, SST88
Dryland Free State Area	Elands	PAN3111, Matlabas, PAN3161, PAN3195
Irrigation areas	SST806	SST835, SST895, SST884, PAN3400

Annexure B – Protocol for updating the Wheat Forum Cultivar list

- The cultivar list to be hosted on the SAGL website is to be named the **Wheat Forum Cultivar List**, to distinguish this list from any other lists already in existence.
- The criteria for listing a cultivar on the Wheat Forum Cultivar List is the *minuted* approval of the cultivar by the Cultivar and Technical Committee of the Wheat Forum. Approval will indicate that the cultivar has passed the evaluation process as described in the 'Analysis Procedure and Evaluation Norms for the Release of Bread Wheat Breeders' lines for the RSA' document.
- Any addition or elimination of a cultivar to/from the Wheat Forum Cultivar List, shall be based on a resolution documented in Minutes of meetings of the Wheat Forum Cultivar and Technical Committee.
- The Wheat Forum Cultivar List shall be updated annually upon receipt of the Minutes of the Wheat Forum Cultivar and Technical Committee meeting.

Annexure C – Wheat Forum Cultivar list

Wheat Forum Cultivar List (Updated April 2019)								
Northern dryland area			Southern production area			Irrigation		
Cultivar	Line name	Year of approval	Cultivar	Line name	Year of approval	Cultivar	Line name	Year of approval
PAN 3282 PAN 3380 SST 3197	PAN2016-4 PAN2016-16 WPT16-13	2019 2019 2019	Tredou	W16/01	2019	PAN 3681 PAN 3582 PAN 3583 PAN 3584 SST 8196	2016PANLE12 2017PANLE4 2017PANLE25 2017PANLE26 B-BPT16-21	2019 2019 2019 2019 2019
Mokolo PAN 3373 SST 3186 SST 3176	T08/21 PAN2015-23 WPT15-03 CWPT13-15	2018 2018 2018 2017	SST 0187	KPT15-28	2018	Usutu PAN 3676 PAN 3474 SST 8175 SST 8176	BSP15/02 2015PANLE35 2015PANLE45 B-BPT14-20 B-BPT14-18	2018 2018 2018 2017 2017
PAN 3252 Kubetu	PAN2013-5 T13/04	2016 2016	SST0166 Steenbok	KPT13-21 W12/12	2016 2016	PAN 3555 PAN 3453 Umzombe PAN 3541 PAN 3644 SST 8154 SST 8156 SST 8155	2013PANLE8 2013PANLE20 BSP13/05 20129ANLE1 2012PANLE20 B-BPT12-03 B-BPT12-06 C-BPT12-03	2016 2016 2016 2015 2015 2015 2015 2015
SST 3149 Wedzi PAN 3133	A-WPT11-09 T10-02 PAN2011-11	2014 2014 2014	SST 0147	KBPT11-21	2014	SST 8145 Renoster Koedoes	B-BPT10-16 BSP10-14 BSP10-15	2014 2014 2014
SST 3137 SST 3127 Kougas	IPT10-08 WPT10-06 T09/16	2013 2013 2013	SST 0137	KPT10-24	2013	PAN 3623 SST 8134 SST 8135 SST 8136	2010PANLE24 B-BPT09-11 B-BPT09-01 B-BPT10-02	2013 2013 2013 2013
PAN 3111	PAN2009-3	2012	SST 0127	09-016	2012	PAN 3515 SST 8126 SST 8125	2009BSPPANLE17 B-BPT09-07 B-BPT09-09	2012 2012 2012
SST 316 SST 317	PT07/4 PT08/6	2011 2011	Ratel PAN 3471 SST 0117	W08-14 PAN 3471 (Irr) 08-012	2011 2011 2011	Timbavati Tamboti PAN 3400 SST 815 SST 816	BSP07/11 BSP07/12 2008BSPPANLE17 B-BPT08-12 C-BPT08-13	2011 2011 2011 2011 2011
PAN 3198 PAN 3195 Senqu Selati Koonap Hartbees	PAN2006-3 PAN2007-15 KGIV07/06 KGOV07/05 KGIV07/09 KGIV07/07	2010 2010 2010 2010 2010 2010	PAN 3434 Kwartel SST 008	PAN 3434 (Irr) W05/22 07-017	2010 2010 2010	PAN 3497 SST 805 Umlazi SST 807	2007BSPPANLE17 C-BPT07-14 BSP06/08 C-BPT07-20	2010 2010 2010 2010
SST 398	PT06-08	2009	SST 096	06-00011	2009	PAN 3489 SST 895 SST 896 Sabie	2006PANLE35 B-BPT06-03 C-BPT06-02 BSP06/17	2009 2009 2009 2009
SST 374 SST 387 PAN 3172 PAN 3379	E3A04/24 PT05/04 PAN2005-2 PAN2005-23	2008 2008 2008 2008	SST 087	05-0006	2008	SST 884 PAN 3471 PAN 3478	B-BPT05/19 2005BSPPANLE31 2005BSPPANLE28	2008 2008 2008
PAN 3161 PAN 3368	PAN2004-4 PAN2004-25	2007 2007	Tankwa SST 077	W03/21 04-0021	2007 2007	SST 877 SST 875 Buffels	BPT04-07 BPT04-05 BSP03/12	2007 2007 2007
SST 963 SST 366 SST 308 SST 319 PAN 3355	02WE3B-10 PT04/3 PT04/4 PT04/5 PAN2003-2	2006 2006 2006 2006 2006	SST 064 SST 067	03-0107 03-0110	2006 2006	SST 867 SST 866	BPT03-3 BPT03-7	2006 2006
SST 946 SST 356 SST 954 PAN 3144	01PT9 02WE3B-9 02WE3B-12 PAN2002-27	2005 2005 2005 2005	SST 047 SST 056 SST 026	02-0031 03-0101 03-0103	2005 2005 2005			
SST 935 SST 347 Matlabas Nossob	01PT11 01PT23 KGIV01/02 KGIV01/03	2004 2004 2004 2004	Kariega SST 035	Kariega (Irr) 03-0102 (SST 835)	2004 2004	PAN 3434 Duzi Krokodil	2001LE2 KGIB01/01 KGIB01/02	2004 2004 2004
PAN 3120 PAN 3122 SST 322 SST 334	EW/PAN9902 EWPAN2000-20 09WP52 00WP17	2003 2003 2003 2003				SST 835	BPT00-6	2003
PAN 3118 Tarka Komati	PAN9911 T98/5 T98/8	2002 2002 2002	Baviaans SST 027	BSP97/1 00-0005	2002 2002	CRN 826	BPT002/E3	2002

Northern dryland area			Southern production area			Irrigation		
Cultivar	Line name	Year of approval	Cultivar	Line name	Year of approval	Cultivar	Line name	Year of approval
			PAN 3404	98PANLE15	2001	Olifants	BSP98/8	2001
			PAN 3408	98PANLE29	2001			
			Steenbras	KBSP95/26	2001			
			SST 015	99-0001	2001			
			Biedou	W98/22	2001			
SST 399	07WPT-40	2000	PAN 3492	96LE1	2000	Baviaans	BSP97/1	2000
PAN 3191	9622	2000	PAN 3490	95LE14	2000	SST 806	97E3-3-6	2000
			SST 94	S97/3138	1999	Steenbras	KSBP95/26	1999
Elands	T95/14	1998	SST 88	S96-239	1998	SST 885	35F5x6-57	1998
PAN 3377	9504	1998				SST 886	35F4x6-44	1998
SST 983	IPT14	1998						
PAN 3364		1997				SST 876		1997
SST 972		1997						
Caledon		1996						
SST 964		1996						
SST 367		1996						
SST 363		1996						
SST 966		1996						
Gariep		1995	SST 57		1995	Inia		Not available
Limpopo		1995	SST 65		1996	Kariega		1993
PAN 3349		1995				SST 822		1993
SST 936		1994				SST 825		1993
SST 333		1993				Marico		1992
Betta DN		1992						
Carina		1989						
Hugenoot		1989						
Carol		1987						
SST 124		1987						
SST 107		1984						
Belinda		1971						