SPREADMARK

AUDITORS

REPORT

COMMISIONED

BY

NEW ZEALAND GROUNDSPREAD ASSOCIATION

CONDUCTED

BY

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BACKGROUND

DEVELOPMENT OF SPREADMARK

SPREADMARK is a scheme for calibrating, testing and certifying machines used to spread fertilisers and lime from the ground. It was developed collaboratively between the New Zealand Groundspread Association and Lincoln Ventures Ltd and drew heavily on the technical work undertaken by the New Zealand Institute of Agricultural Engineering (NZAEI). The scheme commenced in 1994.

The purpose of SPREADMARK reflected the desire of the Association 'to encourage high quality workmanship by its members and enhance the standing of the Association and its members in the fertiliser industry'.

A manual was produced (SPREADMARK: The Calibration and Certification of Fertiliser Spreading Machines. Lincoln Ventures Ltd 1994) which outlines the respective responsibilities to, and standards for, SPREADMARK.

Currently the scheme is managed and administered by the New Zealand Groundspread Association, with Lincoln Ventures Ltd responsible for conducting the tests and issuing certificates.

In respect to the standards adopted and applied the manual states 'when setting a standard for fertiliser application for the Groundspread Association it has to be kept in mind that the requirement is to set a standard that a professional body should reasonably achieve'.

This statement reflects the prevailing philosophy and attitude at that time and is important in setting the context of this audit. SPREADMARK, as currently defined and administered, was seen as a first step in an ongoing process of self-improvement. Accordingly, because of the complexity of the subject, a certain level of pragmatism was applied and 'simple' standards were set which were believed to be achievable.

DEVELOPMENT OF QUALITY ASSURANCE (QA) SYSTEMS

SPREADMARK has been developed at a time when voluntary QA systems and Codes of Practice have been actively encouraged by central and regional governments as a mechanism for implementing and complying to the Resource Management Act 1992. This is preferred to any regulatory approach.

There is a perceived, but yet unrealized, financial benefit for those who embrace and implement such schemes relating to the international consumer demand for 'clean green' products produced from sustainable agricultural systems that do not adversely affect the environment.

In this broader context the development and the ongoing improvement of SPREADMARK is very significant and important.

This context also invites SPREADMARK to be seen and considered together with other relevant QA systems, either in existence or being developed.

Currently, Federated Farmers, together with other agencies, is developing a comprehensive QA system (EQUAL) for the dairy industry. EQUAL will cover all aspects of the operation of the on-farm component of the dairy industry, including the planning, purchasing and applying of fertiliser

The New Zealand Fertiliser Manufacturers Association (NZFMRA) has recently developed a Code of Fertiliser Practice. Both central and local government have now accepted this Code, and providing farmers use the Code, a permit to apply fertiliser will not be required. There is already a commitment (Mr Jim Cotman, pers com) to incorporate the Code of Fertiliser Practice into the EQUAL system.

The Code of Fertiliser Practice is voluntary and encourages the use of all Best Management Practices related to the purchase and use of fertiliser. This potentially includes SPREADMARK and FERTMARK, the latter being QA system operated by Federated Farmers covering the chemical integrity of fertiliser products.

For these reasons it is relevant to this audit to consider SPREADMARK and its 'sister' FERTMARK as components of the Code of Fertiliser Practice which is itself a component of EQUAL (It is assumed that other components of the pastoral industry will also develop their own sector QA systems which incorporate the Code of Fertiliser Practice).

The New Zealand Groundspread Association should encourage the view that SPREADMARK, together with FERTMARK, are essential components of the Code of Fertiliser Practice. This context should encourage the acceptance and adoption of SPREADMARK.

Recommendation 1: That the New Zealand Groundspread Association promotes SPREADMARK as an essential component of the Code of Fertiliser Practice.

BRIEF

After discussion with members of the NZ Groundspread Association, NZ FMRA, BOP Fertiliser Ltd, Ravensdown Fertiliser Co-op Ltd and Lincoln Ventures Ltd, a set of four issues relevant to the conduct and operation of SPREADMARK were identified (Appendix 1).

After discussion, the NZ Groundspread Association instructed that an audit of the technical aspects of SPREADMARK only (Issue 3) be undertaken as a matter of priority. This report should however be considered as the first step towards evaluating all components of SPREADMARK.

AUDIT PROCESS

To achieve a high level of rigor and objectivity, the audit was conducted in three phases;

1. Familiarization: reading of the SPREADMARK Handbook and other base documentation and observing the testing and certification in the field.
2. Justification: identifying the key technical procedures and standards of SPREADMARK and reviewing the experimental justification for these.
3. Benchmarking: comparing the technical criteria of SPREADMARK against comparable international schemes.

It is convenient to report on these matters in the context of the Benchmarking exercise. Recommendations for consideration will be made as they arise in the discussion.

BENCHMARKING

COMPARABLE SCHEMES

SPREADMARK was compared with similar schemes in Europe, USA and Australia. Complete copies of the technical descriptions of these four schemes are attached in Appendix 2 and the relevant contact people and organizations are given in Table 1.

Table 1: Schemes Compared in the Benchmarking Exercise

Country	Scheme	Testing Organization	Contact
New Zealand	SPREADMARK	Lincoln Ventures Ltd	Mr Russell Horrell
Australia	ACU-SPREAD	Longerenong College, University of Melbourne.	Mr Brendon Williams
USA	ASAE	Not specified (typically manufacturers and extension staff)	Dr Richard Parrish
European Union	European Standard (ES)	Research Centre Bygholm, Denmark	Mr Krister Persson

The European Standard (ES) is designed to test manufactures models on a compulsory basis. If a machine achieves the required standard then all copies of that make and model are automatically deemed to have reached that standard. Supporting this official testing there are numerous independent businesses offering machine-testing services at the contractor and farmer level (e.g. Independent Machinery Advisory testing Services, UK, Mr. John Crowe pers. com.).

If the required standard is achieved a report (not a certificate) is issued by the testing organization which describes the machine and sets out its technical specifications. A handbook is also required describing the operation of the machine.

The ASAE scheme is applied on a voluntary basis to new and existing machines. Manufacturers and agricultural extension staff, who may or may not apply the ASAE standard, conduct the testing. No certificate or handbook is issued.

Importantly, under the European and USA schemes, machines are not issued a certificate of 'fitness' indicating that the standard has been achieved. In the case of the ES scheme, the intention is not to test as many machines as possible.

This is very different from the situation in New Zealand and Australia, which both operate voluntary schemes designed to certify specific machines, and hopefully as many as possible. Both of these schemes produce a copy of the test report and a certificate. In the case of SPREADMARK the certificate is valid for two years.

The ACU-SPREAD system, operated for the Australian Fertiliser Services Association, is unique among these four schemes, in that it requires that both the machine and the operator be certified.

ANALYSIS

From the documentation provided, and from correspondence, the technical descriptions and standards of each scheme have been summarized under the headings: Facilities, Products, Equipment, Collectors, Conditions and Measurements (Appendix 3.1 to 3.5).

<u>Test Facilities</u>
All the schemes, with the exception of ACU-SPREAD, allow for both indoor and outdoor testing (Appendix 3.1). In the case of ACU-SPREAD, I was informed (Mr Donald Carter pers. com.) that Australia is too big to have a centralized indoor facility.

The ASAE scheme in particular makes it clear that the preference depends on the purpose of the test. For example, if the specific purpose of the test is to make adjustments to the field performance of the machine then it is logical to conduct that test under the circumstances in which the machine is operated. Equally there are circumstances, such as may occur during the development or refining of the machine, that it is desirable to remove the confounding effects (eg wind, surface and slope) of the outdoor environment.

The qualification is that the conditions under which outdoor testing are conducted must be such so that the results are not rendered invalid. It is noted in this regard that SPREADMARK does not specify minimum requirements of wind speed, direction of travel relative to the wind, surface condition or slope, for outdoor testing.

In addition, it is noted that the size of the indoor facility used for the ES is approximately double that specified under SPREADMARK. This is an important issue. The size of the indoor facility must be sufficient such that the test can be conducted with the machine operating in a stable condition. I understand that modern computer-aided machines need more time for this to occur.

Given that it is the intention of SPREADMARK to be more inclusive, and given that indoor facilities are not always available, and the costs involved in moving machinery to an indoor facility, it is logical that SPREADMARK should encourage and conduct both indoor and outdoor facilities.

***Recommendation** 2:* It is recommended that SPREADMARK reconsider the minimum requirements for an indoor testing facility taking into account the time and distance required for modern computer- assisted spreaders to stabilize.

Recommendation 3: It is recommended that SPREADMARK set, and make explicit, minimum requirements for wind speed, direction of travel relative to wind, slope and surface condition, required for valid, reliable outdoor testing.

Recommendation 4: On the proviso that recommendations 2 and 3 are accepted, it is recommend that SPREADMARK specifically encourage and allow both indoor and outdoor testing.

If these recommendations were implemented, SPREADMARK would achieve a standard of practice equal to, and in respect to versatility, better than current international practice.

Test Products

Number of products: The ES sets the highest standard with regard to the number of products to be tested. It requires that 6 products be tested, each at 3 rates, except for the static tests (eg measurement of flow rates) (Appendix 3.2).

The likely reason for this is that the indoor facility used in Denmark is fully automated, enabling many tests to be conducted at a relatively low cost. This enables the testing of many products x rate combinations fully representative of the range of products available in the EU and at the range of rates used in practice. Such comprehensive testing is not possible at reasonable costs with manual systems.

The ASAE requires that only a single granulated product is tested. This is so despite the fact that a wide variety of products, in terms of their physical properties, are used in American agriculture. This apparent lack of rigor reflects the purpose of ASAE which is to set a standard as distinct from certifying a machine for practical use (Dr Richard Parish pers com).

The Australian and New Zealand schemes lie between these extremes but SPREADMARK has a more comprehensive requirement in terms of the number and type of products to be tested.

Physical Measurements: In terms of measuring and recording the physical properties of the test products, both ACU-SPREAD and SPREADMARK require particle size analysis but only the former requires that the bulk density (BD) of the test product is recorded.

Both the ES and ASAE require other physical measurements in addition to particle size and bulk density. While there may be a theoretical basis for including these measurements their practical significance is remote. It is unlikely that SPREADMARK would be improved at this time by including these additional tests.

Does SPREADMARK meet these international standards?

Before considering the answer to this question it is first necessary to consider the nature of the New Zealand fertiliser industry. In particular, what is the range in the physical parameters of the fertiliser products frequently used?

Data from a number of sources is summarized in Table 2.

Table 2: The mean and range in Mean Particle Size (MPS) and Bulk Density (BD) of some New Zealand fertilisers (R Horrell pers com, K Murray pers com, P Bishop pers com).

Fertiliser	Mean Particle size (mm)	Bulk Density (tonnes/m^3)
Superphosphate	2.48 (2.45-3.02)	1.03-1.28
Potash superphosphate	2.19 (1.34-2.86)	Not available
Cropmaster 20	2.57 (2.49-2.61)	Not available
Urea	3.23 (2.90-3.40)	Not available
Potash	1.59 (0.94-2.24)	1.10-1.20
DAP	3.02 (2.66-3.35)	0.91-1.00
Ammonium sulphate (standard)	1.36 (0.90-1.62)	1.02-1.10
Ammonium sulphate (gran)	2.74 (2.67-2.79)	1.02-1.10
Lime	0.60 (0.20-0.36)	Not available

There is considerable variation within products and between products. It is likely that this does not fully represent the 'real' situation. Particle segregation during transport and storage, and blends of products with incompatible particle sizes, probably means that there can be variations at least as great as indicated above at the truck-to-truck level.

What is clear is that the New Zealand Groundspread industry must cope with a wide range of variation in fertiliser products. It follows that the products tested for the purposes of SPREADMARK should reflect this variability. This is the purpose of the current qualitative requirement of three products; urea, a 'normal' product and one with a high proportion of fines.

There is considerable evidence that indicates that there is a qualitative relationship between mean particle size (MPS), and the optimal bout width (BW) (R Horrell pers com). Indeed, evidence was presented showing that there is a quantitative relationship between these variables (see figure page 5; Appendix 4).

If this is generally the case, (and it is accepted that such relationships may be machine specific), then it is reasonable to suggest that such relationships would provide the basis for a more objective selection of test products. For instance, three products with a MPS of 1, 2 and 3 mm could be specified rather than generic products.

This would eliminate the problem that arises by specifying generic products which can themselves vary considerably within shipments, batches and dispatches (e.g. superphosphate).

But there are other compelling reasons for adopting this approach. Once the relationship between MPS and BW is known for a given machine, and assuming the machine it certified for three products of three different MPS, the operator need only determine the MPS of any particular truck load to know the appropriate BW to use. This is discussed further under the section **MATTERS ARISING**.

Recommendation 5: It is recommended that the SPREADMARK specifications be amended so that the choice of the three test products is based on their MPS (suggest 1,2,3 mm) rather than the current more general requirement.

Adopting this would mean that SPREADMARK has the highest standard internationally for selecting test products. Providing the range in MPS of the test products covers the range of commercially available products then the number of test products is largely irrelevant.

The BD of fertilisers is required, at least in modern computerized spreaders, to calibrate the flow rate and hence the application rate. It is logical therefore that fertiliser BD be added to the particle size analysis as a necessary measurement on all test products. This would also mean that SPREADMARK reaches the same standard as used in Australian, USA and ES.

Recommendation 6: That fertiliser bulk density be added to the list of fertiliser physical characteristics that is required be measuring and reporting under SPREADMARK.

Test Conditions

In terms of the test conditions, SPREADMARK sets similar standards to those internationally (Appendix 3.3). The exception is the number of passes made over the collecting trays.

Evidence was presented (Mr R Horrell pers com) which shows that averaging the results from multiple passes results in significant overestimation of BWs (Table 3).

Table 3: Effect of averaging the weights of fertiliser collected from multiple passes on maximum allowable bout width (BW) (R Horrell pers com)

Machine	Product	Pass No	Maximum BW (m)
Amazone	Nitrophoska blue	1	23.5
		2	19.0
		3	22.5
		4	20.5
		Average	29.5

The reason for this is that transverse variation is smoothed out when the weights of fertiliser collected from single passes are averaged. Hence the CV decreases and the allowable BW increases. In effect a poorly performing spreader, as was the case in this example, could meet the CV standard required simply by replicating the number of passes and averaging the results!

For this reason it is concluded that the system used by SPREADMARK is technically superior to those used elsewhere.

It is my understanding that multiple passes are conducted in the other schemes to ensure that sufficient material is collected for accurate weighing. This, given the evidence above, is spurious logic – to correct one error another is created!

In any case the precision and accuracy of the weighing system used by SPREADMARK is sufficient for a single pass even at low rates of application.

<u>Collectors</u>

With the exception of the unique system used by the ES, the standards adopted by SPREADMARK in terms of the number, frequency, spacing and design of the collectors are as good as, and in most aspects, superior to international best practice (Appendix 3.4).

For the purposes of this audit, 'experiments' were conducted comparing BWs obtained with the current SPREADMARK system, with half the number of collectors, or with the collector inserts at different orientations. The results are summarized in Table 4 below.

Table 4: Maximum allowable bout widths (BW) determined using the SPREADMARK Collectors at normal spacing (1 m c to c) or with alternative Collectors removed (2 m c to c) either to the right (R) or left (L). (R Horrell pers com).

Machine	Product	Collector orientation	Maximum Allowable BW (m) @ cv =15		
			Normal	R	L
Amazone	Nitrophoska blue	Normal	20.5	20.5	21.0
Amazone	Nitrophoska blue	Normal	19.5	19.5	20.5
Amazone	Nitrophoska blue	At right angles	26.0	29.5	25.0
Vicon	Nitrophoska blue	Normal	24.0	24.5	24.5
Vicon	Hydro green	Normal	21.5	22.0	22.5
Amazone	Nitrophoska blue	All at right angles	27.0	ND	ND
		All parallel	29.0	ND	ND
		Alternating	27.0	ND	ND

Note 1) ND = not determined

These results suggest that the orientation of the inserts and the spacing of the collectors have little practical impact on the estimated BWs, at least over the range compared above.

Furthermore, a comparison was made between the SPREADMARK collector system (1m c to c) and that used by Transpread (different collectors at different spacing (2 m c to c). The results (Table 5) show that there is little practical difference between these systems.

Table 5: Effect of different collectors and spacing on bout width (R Horrell pers com)

Machine	Product	Collectors	Maximum allowable BW (m)
Transpread	Superphosphate	SPREADMARK (1m c to c)	28.5
		SPREADMARK (2m c to c)	28.5
		Transpread (2m c to c)	27.5
Transpread	Urea	SPREADMARK (1m c to c)	15.5
		SPREADMARK (2m c to c)	15.0
		Transpread (2m c to c)	14.0

These data collectively indicate that the SPREADMARK collector system is over-engineered for the accuracy required. It may therefore be possible to reduce the number of collectors used per pass in SPREADMARK, thereby reducing the cost of each pass.

***Recommendation** 7:* That SPREADMARK give consideration to modifying the collector matrix by reducing the number of collectors per pass.

Measurements

Transverse CV: The criteria for transverse CV are similar for all schemes (Appendix 3.5), except that ASAE does not specify a minimum CV. Where differences exist they reflect differences in the precision required for the respective agricultural systems (the mix of cropping vrs pastures) and the types of products frequently used (high analysis vrs low analysis). This is reasonable. QA systems should be specific to some extent to the system for which they are designed.

Only the European scheme includes consideration of boarder spreading, the effects of reduced width spreading, rearward throw and hopper volume. These are not requirements of SPREADMARK because they are either irrelevant or of low priority to the New Zealand situation.

Longitudinal CV: The measurement of longitudinal variation is obligatory in Australia and is optional in New Zealand. It is not measured in the EU and USA schemes.

Under the Australian scheme longitudinal variation is measured either by a single pass over 2 sets of collectors (spaced 20m apart) or two passes over a single set (not averaged). The test is repeated if the BWs differ by more than 2m.

According to Lincoln Ventures Ltd (R Horrell pers. com.) the longitudinal CV for New Zealand machines and products is typically less than 5%, providing the feeding mechanism is operating at sufficiently high speeds. For this reason it is a requirement of SPREADMARK that 'the feed gate should be lowered and the belt or chain speed increased when using low application rates'. Thus SPREADMARK attempts to prevent longitudinal variation rather than measure it.

Evidence was presented (Mr R Horrell pers. com.) giving results from experiments where replications of single passes were made. The results are summarized in Table 6.

Table 6: Mean and range in bout widths determined from replications (not averaged) of a single pass (R Horrell pers com).

Machine	Product	Number of Replications	Mean and range in maximum bout width (m)
Local	Superphosphate	2	20.7 (20.0-21.5) (@ cv = 25)
Amazone	Nitrophoska blue	4	22.5 (19.0-26.5) (@ cv = 15)
Amazone	Nitrophoska blue	2	20 (19.5 –20.5) (@ cv = 15)

This suggests that there can be significant longitudinal variation, at least on some occasions with some machines and product combinations. It may be that the one result above is unique. Further experimentation of this type is needed to eliminate this possibility.

Given this conundrum the solution to the problem of longitudinal variation is to either:

1. Adopt the Australian approach and measure longitudinal variation, rejecting the test if the 2 BWs (from the 2 passes) are greater than 2m (or some other distance). This would add cost to the test.
2. Eliminate the factors that give rise to this problem (eg surges in flow rate) at source. This is the approach that has historically been adopted by SPREADMARK.

The ES system is the only one that requires the measurement of flow rate and the variation in flow rate. It is required that this is measured, using one granulated product, at four different slopes. Very clear specifications for variations in flow rate are set.

If it is assumed that variations of flow rate are the sole source of longitudinal variation, then adopting the ES standard requiring the measurements of variations in flow rate is also a potential solution to this problem.

Recommendation 8: It is recommended that SPREADMARK reconsider the issue of longitudinal variation and either a) conduct further experiments covering a range of machine x product combination to determine the extent and size of longitudinal variation or b) adopt the standard used in Australia and measure longitudinal variation as part of the test procedure or c) adopt the ES standard and measure variations in flow rates.

Either option will incur costs but it is noted that if ***Recommendation*** *7* is accepted then it may be possible to measure both transverse and longitudinal variation with the same number of collectors and hence costs, as currently apply.

<u>Rate of Application:</u> Both the ES and ASAE schemes require that the actual application rate (as distinct from the set application rate) is measured. In the latter case it is preferred that this is measured directly but it can be estimated indirectly from the collector weights providing the collector efficiency is known.

It is clear that both the ES and ASAE schemes are designed to measure the transverse spreading pattern, and hence the optimal BW, and the accuracy of the rate of application.

In contrast SPREADMARK and ACU-SPREAD are designed **only** to certify the spreading pattern and optimum BW.

This is a matter that requires serious consideration and hence some discussion is required.

If SPREAMARK is to become an integral component of the Code of Fertiliser Practice it will be necessary that both the accuracy of the rate of application and spreading are measured and certified.

During the development of the SPREADMARK collectors, it was established that the collector efficiency was 97-98% (Mr R Horrell pers comm). Furthermore, information provided (Table 7) (R Horrell pers. com.) indicates a discrepancy between the rate of application measured in the collectors and the set application rate.

Table 7: Differences between the rate of application measured in the collectors and the set application rate (R Horrell pers com).

Machine	Measured Application Rate[1] (kg/ha)	Set Application Rate[1] (kg/ha)	Deviation (%)
Unit 1	193 (n=11)	157	-23
Unit 2	173 (n=10)	162	-5.5
Unit 3	161 (n=9)	148	-8.8
Unit 4	174 (n=19)	171	-1.8
Unit 5	153 (n=18)	141	-8.5

Note 1) mean application rate of a number (n) of fertilisers x rates of application

It is understood that modern computer-aided spreading machines are calibrated in the following manner. The flow rate is calculated based on the bulk density of the fertiliser and other machine-specific mechanical variables. This calculated flow rate is then calibrated against the actual flow rate measured by 'dumping' a tonne (1000 kg) of fertiliser. Any discrepancy is factored into the calculations.

In contrast, the amount of fertiliser collected in the collectors (60) in one pass is between 0.5 to 3.0 kg depending on the rate of application. It is reasonable therefore to accept that the set rate of application from a properly calibrated machine is a more accurate measure of the true rate of application, than that estimated from the collectors.

Indeed this is accepted by SPREADMARK, which places no emphasis on its estimated rate of application. It is not reported on the test sheet and is used only to ensure that the set application rate is within 30% of the collector-estimated rate. (Note that the transverse CV can depend on the rate of application and for this reason machines are certified at the set rate of application +/- 30%).

However, the process of the calibration of the rate of application is undertaken independent of SPREADMARK and is not checked or otherwise audited by a third party. SPREADMARK **assumes** that flow rate and hence application rate of any machine submitted for testing is properly calibrated.

There is of course a practical safeguard. If a machine is not calibrated or not accurately calibrated, this is soon remedied in practice by the operator, assuming that the weight of fertiliser spread and the area covered is known.

Therefore, it is reasonable to conclude that the current system in its entirety is failsafe and therefore meets international standards. This is so despite the fact that the responsibility for calibrating application rates lies outside the jurisdiction of SPREADMARK and despite the discrepancy between the calibrated set application rate and the collector derived application rate as determined by SPREADMARK.

However, the universal requirement for any QA system is that it is transparent. This is so currently for SPREADMARK only in as much as it certifies the spreading characteristics of a machine. But it is not so with regard to the equally important and related issue of certifying a machine with respect to the rate of application.

If it is the intention of SPREADMARK to become a component of the Code of Fertiliser Practice (***Recommendation 1)*** then it is inevitable that those responsible for implementation of the RMA, (the Regional councils) will sooner or latter seek assurance from SPREADMARK that a) the correct rate of fertiliser is applied and b) that the fertiliser in evenly distributed.

The options are therefore to either make it clear that SPREADMARK covers only the latter and establish a new QA system to deal with the former, or, to broaden the jurisdiction of SPREADMARK to include both components.

The latter could be achieved without any duplication of the current effort. It would require only that the body responsible for the spreading tests also become responsible for auditing the calibration process. In turn this would require an appropriate calibration system to be developed and documented and appropriate records kept.

Recommendation 8: It is recommended that SPREADMARK be broadened to include the certification of spreading machinery with respect to the accuracy of the rate of fertiliser application.

CONCLUSION

It is concluded that SPREADMARK as currently designed is technically as good as, and in some respects better than current international standards. This conclusion takes into account the nature of the industry it serves (the range of products and the mix of pastoral and cropping), its development relative to other QA systems in NZ agriculture (EQUAL and the Code of Fertiliser Practice), and in particular the intention of the New Zealand Groundspread Association to certify as many machines as possible.

The recommendations made in this report are designed either to make the current SPREADMARK scheme more explicit and hence transparent, or, are intended so that SPREADMARK is technically superior relative to current international best practices.

MATTERS ARISING

It is inevitable in an audit such as this that issues, problems and potential solutions arise which are technically outside the original brief – to review the technical aspects of SPREADMARK. It is also true that some of the recommendations offered link to other issues relating to the operation and management of SPREADMARK (see Issues 1, 2 and 4 Appendix 1).

The following observations and thoughts are offered in this context.

Linkage between Fertiliser Spreaders and Suppliers

Evidence was advanced earlier showing that there is considerable variation in the properties of fertiliser products available in New Zealand. It was noted that this type of variability probably occurs at the batch and dispatch level. This currently creates difficulties for the spreader operators.

A simple sieve box has been developed and is available which could be used to quickly determine the MPS of any given dispatch of fertiliser (Appendix 4). Similarly a simple rapid method is available to measure the bulk density

It occurred to me that the problem alluded to above could be minimized with these tools and assuming that the relationship between MPS and BW was known. For each unit of fertiliser (this could be done at the truck-to-truck level) the BD and MPS could be determined and the application rate and BW determined. Additionally the sieve box could be used to determine the Uniformity Index (UI) of fertiliser blends to determine whether segregation had occurred.

If this procedure were adopted then it would put the New Zealand spreading industry on a sound technical footing.

Recommendations 5 & 6 were offered, in addition to the reasons already given, with these thoughts in mind.

Operator Certification

Only the Australian scheme requires operator certification. This I believe is something that SPREADMARK should consider, not solely to achieve the Australian standard but also as a mechanism to overcome the problem lying between the fertiliser supplier and spreader.

If SPREADMARK proceeded to put the industry on a firmer technical base as suggested above, then some operator training would be required if for no other reason than to instruct on the measurement of BD and MPS. But this could be the opportunity to introduce some simple technical information about fertiliser properties and how these affect spreading. Examples include the relationship between BD and flow rate and MPS and BW.

If the operators were so instructed and equipped then some of the current problems arising as a consequence of product variability may be resolved on a permanent basis.

SPEADMARK and FERTMARK

It was argued earlier in this report that both of these QA systems should become, given time and effort, integral components of the Code of Fertiliser Practice. This would give additional credibility and impetus to both. This being so the question arises – why not have both schemes managed and administered in the same manner?

Currently FERTMARK is owned and managed by Federated Farmers who have appointed an auditor who in turns checks and audits the work done by those whose products are voluntarily submitted for registration. Note that the auditor does not repeat the tests, they simply make sure that the tests are done to an acceptable standard and that they comply with defined standards.

The same organization and responsibilities could be applied to SPREADMARK. The advantages of this model is that the farmers (the customers) would own it and manage it and an independent authority would audit the records of those who do the testing – as things currently stand Lincoln Ventures Ltd (spreading pattern) and individual operators (rate calibration). The NZ Groundspread Association would remain responsible for the setting of the standards.

A further advantage would be that, to use the vernacular, the judge and the jury would have separate functions.

Publications

In the process of conducting this audit much technical information was made available, some of which is included in this report. This information is very valuable and useful to those involved in the fertiliser industry.

I suggest that SPREADMARK should have this material appropriately summarized and discussed in a formal reference publication. This I believe would ensure that all members of the industry can discuss issues from a common technical basis and enhance the technical credibility of SPREADMARK.

D C Edmeades
November 24, 1999

APPENDIX ONE

SPREADMARK AUDIT

ISSUES

1. Credibility/Acceptance

- Other groups doing 'own thing'. Why?
- Exclusive to members of Groundspread Association. Why?

Question: What are the reasons/factors that currently limit the acceptance and credibility of Spreadmark?

2. Managerial

- Should Spreadmark be managed and administered by the end user eg Federated Farmers?
- Shouldn't the functions of testing and certification be separate?

Question: Would making these changes increase the credibility of Spreadmark?

3. Technical

- Benchmarking against international best practices. How good is Spreadmark?
- Product types (powdered, crystalline, granulated, blended) and variation within types? What is the effect of this variability?
- Indoor vrs outdoor testing

Question: Is the current testing robust in respect to what happens in the field?

4. Education/Training

- Certification of operator?

Question: Would Spreadmark be improved if the operator and the machine were certified?

D C Edmeades
September 7, 1999

APPENDIX TWO

Draft Spreadmark - from Horrell.

THE CALIBRATION AND CERTIFICATION OF FERTILISER SPREADING MACHINES

THE SPREADMARK SCHEME

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- 5.5 Hopper Flow Rates and Application Rates
- 5.6 Evenness of Spreading Measurement (Distribution Tests)
- 5.7 Overlapping the Spread Pattern
- 5.8 Coefficient of Variation
- 5.9 Interpretation of the Calibration
- 5.10 Pre-Testing
- 5.11 Evenness of Spreading in Direction of Travel

6 Data Sheets

7 Reporting the Results
- 7.1 Field Reports
- 7.2 Spreadmark Certification Documents

8 Maintaining Even Spreading

1. INTRODUCTION

The Spreadmark fertiliser calibration and certification scheme is a collaborative undertaking between the Groundspread Association, Regional Association branches and Lincoln Technology. The aim of the scheme is to show the Associations desire to encourage high quality workmanship by it's members and enhance the standing of the Association and it's member in the fertiliser industry.

In general, the responsibilities of the parties are:
National Association – the administration of the scheme
Regional Branches - the practical aspects of spreader calibration
Lincoln Technology - the technical aspects of calibration and certification

To operate the scheme, local organising branches select a suitable venue and make arrangements with the National Association and Lincoln Technology (LT) to carry out a test programme over a specific time period. The branch arranges a supply of manpower, materials and prepares a schedule of spreaders to be tested at specific times.

During the tests, distribution patterns are measured and analysed. The operator sees the results and is able to discuss them with Lincoln Technology staff. There is also an opportunity to make adjustments to the machine and retest. A field report of the test data is given to the operator at this time. Samples of the test fertilisers are taken for later sieve analysis.

After calibration testing, the data from the best tests is reprocessed using the commercial bout width. This is brought together with the sieve analysis of the material to form the test certificate, which is issued by the National Association.
The Spreadmark Certificate is valid for two years then the spreader must be re-tested.

2 FERTILISERS AND SPREADING EVENNESS

2.1 Fertilisers

When setting a standard for fertiliser application for the Groundspread Fertilisers' Association it has to be kept in mind that the requirement is to set a standard that a professional body should reasonably achieve.

The evenness with which a particular fertiliser is required to be spread depends on the fertiliser type, the fertility of the paddock, the crop it's being applied to and the efficiency of the utilisation of that crop. All these factors are beyond the control of the spreading operator.

However, contract spreading machines need to achieve a standard that will **give a satisfactory result regardless of the particular circumstances.** The standards given below are considered to be adequate for agronomic requirements and are mechanically achievable. While they are a simplification of a complex subject, a simple standard is required if it is to be understood and accepted by the spreading operators and their farmer clients.

2.2 Number of Fertilisers for Certification

To ensure that the certificate covers a reasonable range of each spreader's capability, the Association requires that at least three fertilisers be tested. One of these must be Urea. It is strongly suggested that one of the other materials has a high proportion of fine particles, for example crystalline Ammonium Sulphate or similar. It is important that the fertilisers used for certification are representative of those normally used by each spreader.

2.3 Spreading Evenness Standards

2.3.1 Category I, Nitrogen and Nitrogen Compound Fertilisers

Nitrogen must be spread evenly because the crop uses it in the season it is applied without transfer. The following standard will be used to describe spreader performance.

C.V.	less than 5%	Excellent
	between 5 and 10%	Very Good
	between 10 and 15%	Good
	above 15%	Poor

2.3.2 Category II, Non-Nitrogenous (Phosphate, Potassium, Sulphur and Lime)

These elements are held in the soil and are by various means "slower release". The need for evenness is not as great as for Nitrogen. The following standard is therefore satisfactory for the ***maintenance*** application of these fertilisers.

C.V.	less than 5%	Excellent
	between 5 and 15%	Very Good
	between 15 and 25%	Good
	above 25%	Poor

Where an element is ***deficient***, an evenness of plus or minus 15% is required. To achieve that level of accuracy, the spreading standard for Nitrogen should be used.

3 OPERATION OF THE SPREADMARK SCHEME

3.1 Steps and Responsibilities

- Scheduling Overall Timetable National Association

- Local Planning and Preparation Regional Association
  - signing up trucks to be tested Regional Association
  - locating and hiring a venue Regional Association
  - finalising date with all parties Regional Association
  - arranging supply of fertiliser Operators/ Regional Association

- Calibration Tests
  - schedule of spreaders Regional Association
  - setting up equipment Lincoln Technology/Association
  - preparing spreader for each test Operator/Association (2 people)
  - lifting and weighing trays Regional Association (4 people)
  - data analysis Lincoln Technology
  - clean-up of facility Regional Association

- Reprocessing of Data and Sieve Analysis Lincoln Technology
  - preparation of certificates Lincoln Technology

- Issuing of Certificates National Association

- Collection of Certification Fees National Association

3.2 Labour Requirements

The costs of calibration are based on achieving a minimum of 85 runs over the trays in 5 days, ie. 17 runs per day. To achieve this work rate and run this part of the scheme quickly and efficiently requires a total of eight people. Their functions are as follows –

- Measuring spreader and preparing for test (2 people)
  - Spreader supervisor
  - Spreader driver

- Lifting and emptying collecting tray, weighing fertiliser and preparing trayline for next test (4 people).
  - Trayline supervisor
  - Three trayline assistants

- Data processing, preliminary analysis of results and overall supervision, (2 people).
  - Two people supplied by Lincoln Technology

3.3 Equipment Required for Testing

- Venue -A building of at least 25 x 40 metres with clear span sufficient to allow material to enter trays without interference.

- Clean space -A clean workspace adjacent to the test area is required for setting up the computers and where the results can be analysed and discussed. A caravan with tables, set up inside the testing building will be satisfactory

- Trays -60 Groundspread Association trays with anti-bounce inserts. 30 supplied by branch and 30 held by Lincoln Technology.
- Anti-bounce -Lime or an equivalent fine material spread 25 mm deep prevents bounce from the floor into the trays. Sufficient for 30 metres wide x 5 m and 25 mm deep = 3.75 m^3.
- Scales -Lincoln Technology to supply
- Computer -Lincoln Technology to supply
- Printer -Lincoln Technology to supply
- Fertilisers for test -These are to be supplied by the spreader operator or the Regional Association. Sufficient fertiliser is required to ensure the feeder belt or chain is well covered at the end of each run. The amount of fertiliser required is about 50 kg per test run (ie. 20 spreaders @ one run each with urea = 1000kg – 1 tonne).
- Minor Equipment - Tarpaulin to empty excess fertiliser onto
  - Shovels for re-bagging fertiliser
  - Garden rake for loosening the anti-bounce

3.4 Running the Tests

Normally at least 3 spreaders are under test at any particular time. This allows for concurrently, one set of data being processed, the next run being weighed and a further spreader being prepared for it's next test run. Spreaders may be temporarily withdrawn for modification etc. and rejoin the testing queue later.

Before and during certification testing, spreaders may do a cheaper "pre-test" to check that performance is near certification standard (see section 5.10).

3.5 Outdoor Testing

If no suitable building is available, the tests may be conducted outdoors. Because of variable weather conditions and the need for wind speed and direction measuring equipment, testing of this type will be subject to negotiation on a case by case basis.

4 PREPARING THE SPREADER FOR TEST

The spreader should be prepared for test by ensuring that it is clean and in a sound mechanical condition. Any build up of fertiliser on the feed shute, discs or back plate should be removed. All mechanical parts and adjustments should be in full working condition. Particular attention needs to be given to the feed gate controlling the depth of material above the chain or belt to ensure that it is adjustable over it's full range. On twin disc units, the disc speeds should be within 3 % of each other.

The Association requires that each spreader has a display of disc speed in the operator's cab and the spreader has some mechanism that allows the flow rate onto the disc/s to be adjusted automatically for changes in forward speed.

5 TEST PROCEDURE

5.1 General

The following series of tests, conducted under controlled conditions, have been designed to establish the settings, bout widths and spreading evenness of broadcast type fertiliser distributors spreading most NZ fertilisers at normal application rates. The method of testing has been devised by Lincoln Technology to suit the particular characteristics of broadcast fertiliser distributors used in New Zealand.

5.2 Operation of the Spreader

The spreading operator is responsible for setting up and operating the machine during the tests. To take advantage of the learning opportunity, the Association and LT encourage each spreaders normal driver to take the unit through the certification process.

The spreader should be operated as near as possible to field settings. Forward speed should be as near to field speed as is safely achievable over the tray line. The application rate should be the average for the fertiliser type. To ensure longitudinal evenness, the feed gate should be lowered and the belt or chain speed increased when using low application rates.

5.3 Fertilisers used in the Tests

Samples of the fertiliser will be taken for sieve analysis and the analysis will form part of the test report. The standard sieve sizes used are – 4.0, 3.35, 2.8, 2.0, 1.4, 1.0, 0.5 and Pan. Care should be taken to ensure that the particle sizes of the fertilisers tested are representative of those normally used by each spreader. This may mean that a operator will need to bring his "local" fertiliser to the test venue.

5.4 Explanation of Terms Used

Some of the terms used in the text are graphically shown in Figure 1.

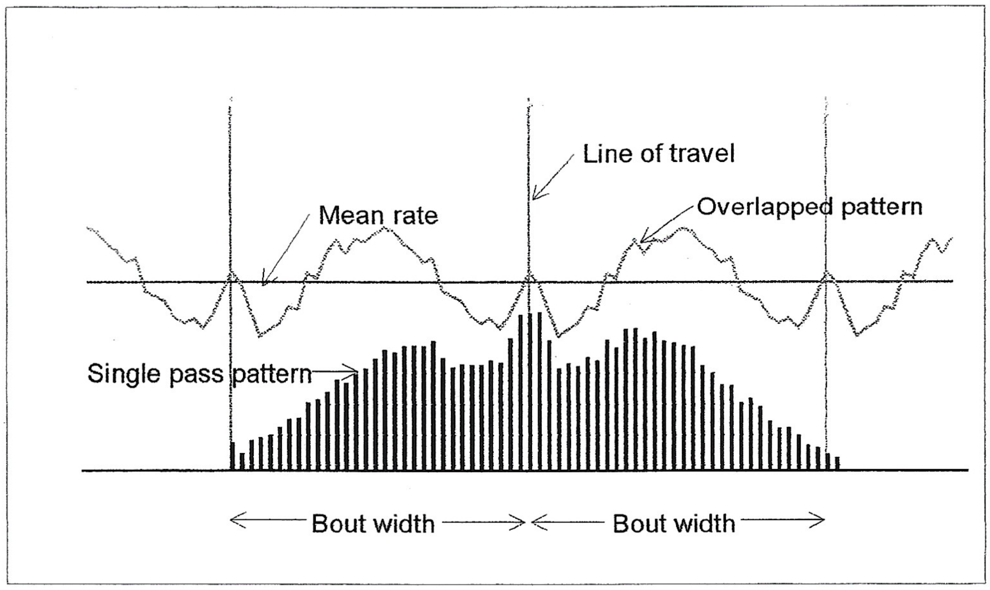

Figure 1. Explanatory Diagram

- Single Pass Pattern
  The shaded area represents the pattern of fertiliser laid down by a single pass of the spreader. The height at any point of the shaded area indicates the weight of fertiliser deposited at that point.
- Bout Width
  Distance between successive passes of the spreader across the field.
- Overlapped Pattern
  The pattern of fertiliser laid down by successive passes of the spreader at a particular bout width.
- Mean Rate
  The average overall application rate.
- Coefficient of Variation (CV)
  The coefficient of variation is a statistical term which is calculated from the Overlapped Pattern and is a measure of the average variation from the Mean Application Rate (perfectly even spreading would give a zero CV value).
- Mode of Travel
  The path of travel of the spreader across the field. This may be Round and Round or To and Fro.

- Recommended Commercial Bout Width
  This is normally the maximum bout width at which even spreading for the particular fertiliser has been achieved and which also allows a margin of one metre for driver

variation. However lesser bout widths may be certified provided they meet the required standards given in section 2.3.

5.5 Hopper Flow Rates and Application Rates

Flow rates are not normally be measured before the calibration tests. However the outputs from the test allow the flow rate to be simply calculated. Because changes in flow rate on to the disc can change the distribution pattern, the calibration test and certification are valid only for flow and application rates within 30% of that tested. During the distribution tests the hopper flow should be adjusted to give the normal application rate for the fertiliser type. Fertilisers that are applied at both low and high rates may need two certificates to cover the full range of application rates. The actual application rate of the test run is calculated and given with the results.

5.6 Evenness of Spreading Measurement (Distribution Tests)

A single row of Ground spread Association collecting trays are laid out at right angles to the direction of travel and at a spacing of 0.5 metres from tray centre to tray centre. Gaps are left for the vehicle wheels to pass through the trayline and trays under the vehicle are adjusted to ensure maximum data collection.

Where possible 60 trays covering 30 metres are used, however if venue constraints preclude a full trayline, the outer edge of the spread pattern may have to be calculated. The tray line is surrounded by material to prevent fertiliser granules bouncing off the floor into the trays. A 25-mm deep layer of lime is satisfactory for this purpose, provided it is kept soft and loose by raking.

The spreading test consists of one pass of the machine through the row of trays, during which the hopper outlet of the machine will be kept covered with fertiliser. The weight of fertiliser collected in the individual trays is weighed and makes up the Single Pass Pattern and this is used to calculate the Overlapped Spread Pattern.

5.7 Overlapping the Spread Pattern

The Single Pass Pattern as measured in Section 5.6 is over lapped at 0.5 metre increments of bout with by computer for both Modes of Travel across the field. The overlapped pattern is illustrated at a commercial bout width.

A typical Overlapped Spread Pattern graph is illustrated in Figure 2. The shaded area represents the single pass pattern, while the unbroken Overlapped Pattern (green) line shows the distribution achieved when adjacent patterns are overlapped at the selected bout width. Positions across the Overlapped Pattern line that coincide with 100 on the vertical scale (Percentage of Mean Rate), would receive the fertiliser at the Mean Application Rate. For perfect spreading, the Overlapped Pattern line would lie across the graph on this 100 percent line.

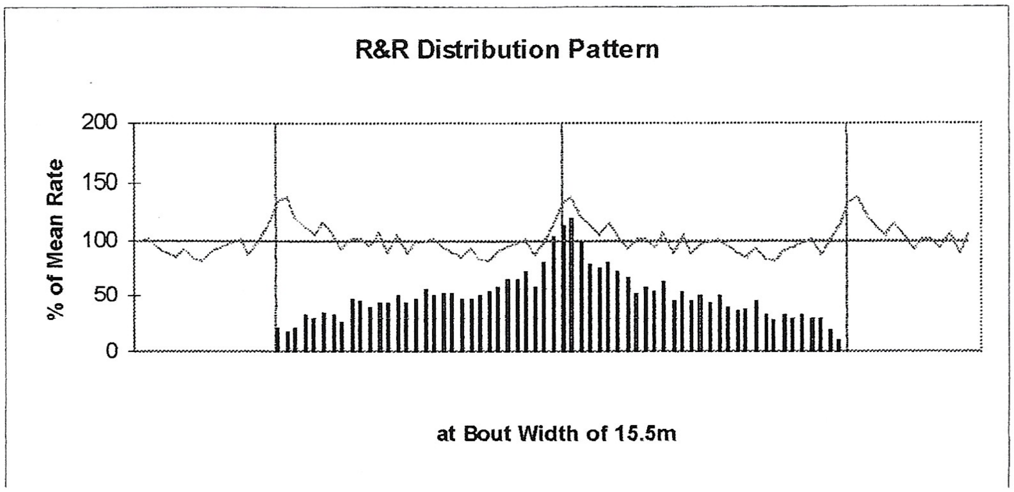

Figure 2: Overlapped Spread Pattern Graph

5.8 Coefficient of Variation

The Coefficients of Variation of the Overlapped Pattern is calculated over a selected range of Bout Widths (normally 5 to 25 metres). These are presented in graphic form with the lowest point of the curve indicating the Bout width at which the most even spreading took place (See Figure 3). The Spreadmark evenness standards given in section 2.3 are superimposed on these graphs.

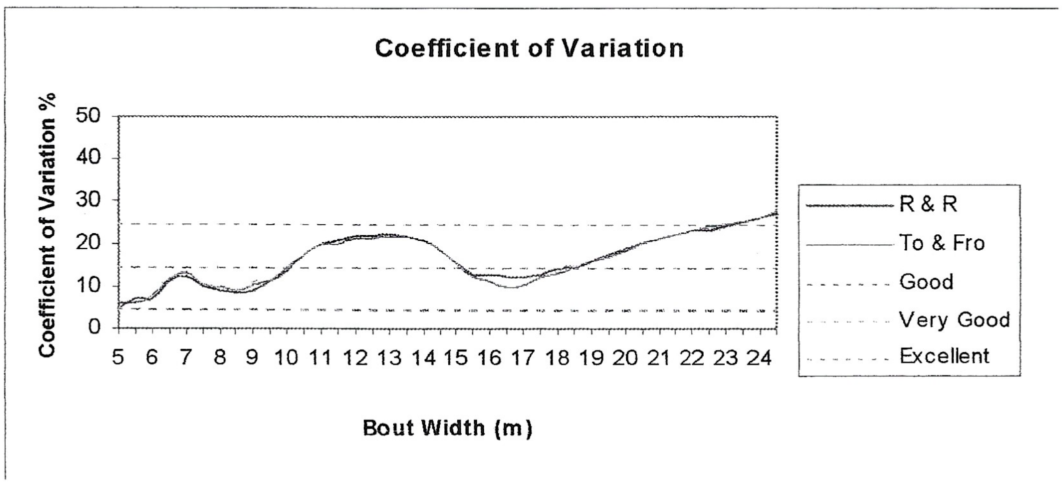

Figure 3: Coefficient of Variation Graph

This graph also indicates the sensitivity of the machine. /fertiliser combination to driving variations. A curve, that has low values over a narrow range of bout widths, indicates a combination, which is sensitive to driving variation. On the other hand, a curve that has its low values over a wide range of bout widths will indicate a combination, which is not so sensitive to driving variations.

5.9 Interpretation of the Calibration

The output from the calibration test is information about the single pass spread pattern, the overlapped pattern and the evenness of the overlapped pattern (the coefficient of variation or CV). The information is then translated into a practical recommendation for driver use. This is expressed in the form of a “recommended commercial bout width”. This is a bout width where the material has given even spreading (no greater than 15% and 25% respectively for the two categories) and an allowance is made for a driver variation of one metre. The application rate measured at that recommended commercial bout width is given and the certification is valid only for application rates within 30% of that measured rate.
The calibration can be reinterpreted for different uses eg. achieving a very low CV for spreading Nitrogen on a sensitive crop.
The calibration measures the machine performance at the time of test in the same way a certificate of fitness represents a vehicle’s condition at the time of inspection. The validity of the certificate will reduce over time because of changes in the fertiliser specification and changes in the spreading mechanism. Therefore certificates will be issued for a period of two years only.

5.10 Pre-Testing

Spreaders may be pre-tested to adjust performance at any time during the certification process. Pre-tests are carried out in the same manner as the certification tests described above, except a one metre tray spacing is used. Pre-tests are at a reduced cost and they do not qualify for certification.

5.11 Evenness of Spread in Direction of Travel (optional)

Test conditions as specified in Sections 5.2 and 5.3 will apply. The collecting trays are laid out in two rows parallel to the direction of travel for a distance of ten metres. Each row is 3 metres from the centre line. The spreader is driven once between the trays at approximately field speed. The weight of material from the corresponding trays in the two rows is added together and the results presented graphically. This test is carried out at the same flow rate used for the spreading tests.

6.0 DATA SHEETS

Two types of data sheets are required to be filled in during testing.

- A **Spreader Details** sheet must be completed for each spreader and given to the LT computer operator before testing commences. These details are used to create a computer file for that spreader and they will also be printed on the Spreadmark Certificate. Care must be taken to ensure the details are correct

- A **Test Run Sheet** must be completed and given to the LT computer operator before each test run. It has the details about the fertiliser and spreader settings which must be entered into the computer before the collecting trays can be weighed.

Copies of these data sheets are enclosed.

The NZGFA requires each operator submitting a spreader for test to complete a “CONTRACT LETTER RE SPREADMARK TESTING” and this must be completed before Lincoln Technology is able to carry out any work.

7.0 REPORTING THE RESULTS

7.1 Field Reports

During testing, the results from each test run are given in a two page Field Report. This contains spreader details, single pass and overlapped patterns and a CV graph for both travel modes. It also has tables of collecting tray weights, and CV's and application rates for all bout widths.

Selection of the test runs and bout widths to be used for certification is done by consultation between the spreader operator and LT staff.

7.2 Spreadmark Certification Documents

The data from the field tests is reprocessed at the certifying bout width and the fertiliser sieve analysis data is added to make the Spreadmark Certificates.

The Spreadmark Certification documents consist of a –

- The Certificate giving the spreader details, the fertilisers, the certifying bout widths and CV's. This document is signed by the Association President and the Testing Officer from LT and is suitable mounting on an office wall.
- A Certification sheet giving spreader details, fertilisers, certifying bout widths, application rates and disc speed. This sheet also has graphs of single pass and overlapped patterns, CV results and fertiliser sieve analysis for each certifying fertiliser. It is folded A3 in size and is laminated for protection. It is usually carried in the spreader cab and shown to farmer clients as proof of Certification and spreader performance.
- A sticker giving the fertilisers and the certifying bout widths that can be mounted inside the windscreen.

All documents have the Spreadmark Certificate number and the re-test/expiry date.

The Spreadmark Certification Documents are available from the Association National office shortly after testing when all fees have been paid.

8.0 MAINTAINING EVEN SPREADING

The calibration and certification scheme can only measure the performance at the time of the test (like a vehicle Certificate of Fitness). It is therefore important that the spreader is maintained in good working condition and not modified or changed after the certificate is issued. The certificate is valid for two years, after which the spreader should be retested. The tests are carried out in still air conditions. The recommended bout width will give good performance under similar conditions, however there will be a loss of performance if significant wind or slope affects the spreader. The certification is only valid for application rates within 30% above and below those tested.

from Dick Parish.

Current ASAE S341.2	Proposed Revision	Rationale
	Unapproved Draft for Review Only	
	Revision Proposed by PM-41/3	
PROCEDURE FOR MEASURING DISTRIBUTION UNIFORMITY AND CALIBRATING GRANULAR BROADCAST SPREADERS	**PROCEDURE FOR MEASURING DISTRIBUTION UNIFORMITY AND CALIBRATING GRANULAR BROADCAST SPREADERS**	
	January, 1999 - Draft #2.3	
SECTION 1 - PURPOSE AND SCOPE	SECTION 1 - PURPOSE AND SCOPE	
1.1 The purpose of this Standard is to establish a uniform method of determining and reporting performance data on broadcast spreaders designed to apply granular materials on top of the ground. Tests performed according to this Standard make it possible to predict field performance of the spreader and to compare spreader distribution patterns.	**1.1 Purpose.** The purpose of this Standard is to establish a uniform method of determining and reporting performance data on broadcast spreaders designed to apply granular materials on top of the ground. Tests performed according to this Standard make it possible to predict distribution uniformity of the spreader and to compare spreader distribution patterns.	Heading added to conform to current ASAE practice.
1.2 This Standard pertains to centrifugal, pendulum, and other types of broadcast spreaders designed for dry granular application while operating on the soil surface. Portions of the test procedures outlined herein are suitable for determining the delivery rate of gravity or drop spreaders; however, additional tests not covered in this Standard are needed to completely evaluate the performance of gravity spreaders. This Standard does not cover dry pneumatic granular applicators.	**1.2 Scope:** This Standard pertains to centrifugal, pendulum, and other types of broadcast spreaders designed for dry granular application while operating on the soil surface. Portions of the test procedures outlined herein are suitable for determining the delivery rate of gravity or drop spreaders; however, additional tests not covered in this Standard are needed to completely evaluate the performance of gravity spreaders. This Standard does not cover dry pneumatic granular applicators.	Heading added to conform to current ASAE practice.
	SECTION 2 - NORMATIVE REFERENCES ANSI Z23.1, Specifications for Wire-Cloth Sieves for Testing Purposes ASAE S281, Capacity Designation for Fertilizer Pesticide Hoppers and Containers	References moved to this location to conform to current ASAE practice. Later references to standards changed to number only. Removed unneeded reference to S203.

Current ASAE S341.2	Proposed Revision	Rationale
	ASAE S327, Terminology and Definitions for Agricultural Chemical Application	
SECTION 2 - DEFINITIONS	SECTION 3 - DEFINITIONS	Alphabetized to conform to ASAE policy.
2.3 One-direction application: An application method where successive adjacent swaths are made in the same direction of travel (racetrack application). This method produces a right-on-left overlapping of adjacent patterns.	**3.1 Application, one-direction:** An application method where successive adjacent swaths are made in the same direction of travel (racetrack or circuitous application). This method produces a right-on-left overlapping of adjacent patterns.	To conform to latest version of S327.
2.4 Progressive application: An application method where the spreader applies adjacent swaths in alternate directions (back and forth application). This method produces a right-on-right pattern overlap alternately with a left-on-left pattern overlap.	**3.2 Application, progressive:** An application method where the spreader applies adjacent swaths in alternate directions (back and forth application). This method produces a right-on-right pattern overlap alternately with a left-on-left pattern overlap.	
2.1 Application rate: Application rates are as defined in ASAE Standard S327, Terminology and Definitions for Agricultural Chemical Application.	**3.3 Application rate:** Application rates are as defined in ASAE Standard S327.	
2.2 Single-pass application: An application method where the spreader applies one swath over the collection trays.	**3.4 Application, single-pass:** An application method where the spreader applies one swath over the collection trays.	
	3.5 Collector efficiency: The percentage of true application rate caught in a collection device; i.e. the weight of material caught in the collection device divided by the area of the collection device and expressed as a percentage of the true application rate at that point in the pattern.	Added to clarify term used in 5.4.5
2.5 Swath spacing: The lateral distance between spreader centerlines for overlapping broadcast applications.	**3.6 Swath spacing:** The lateral distance between spreader centerlines for adjacent swaths.	
2.6 Effective swath width: The swath width that will produce acceptable field deposition uniformity for the intended application.	**3.7 Swath width, effective:** The swath spacing that will produce acceptable field deposition uniformity for the intended application.	To conform to latest version of S327.
SECTION 3 - TEST CONDITIONS	SECTION 4 - TEST CONDITIONS	
3.1 The spreader to be tested shall be in good mechanical condition and shall be properly adjusted.	**4.1** The spreader to be tested shall be in good mechanical condition and shall be properly adjusted.	
3.2 Tests may be conducted on a spreader to		

Current ASAE S341.2	Proposed Revision	Rationale
evaluate an experimental model, to qualify a new production model, or to verify the performance of an existing production model. Tests may also be conducted to evaluate the performance of a spreader and to verify the adjustment of a spreader for a specific granular material being spread under conditions similar to actual field conditions.	**4.2** Tests may be conducted on a spreader to evaluate an experimental model, to qualify a new production model, or to verify the distribution uniformity of an existing production model. Tests may also be conducted to evaluate the distribution uniformity of a spreader and to verify the adjustment of a spreader for a specific granular material being spread under conditions similar to actual field conditions.	
3.3 The geometric specifications shall be checked with the machine standing on an impenetrable, horizontal surface in normal operating position. Dimensions of length and width shall be measured along horizontal lines and dimensions of height along vertical lines.	**4.3** The geometric specifications shall be checked with the machine standing on an impenetrable, horizontal surface in normal operating position. Dimensions of length and width shall be measured along horizontal lines and dimensions of height along vertical lines.	
3.4 It is recommended that the manufacturer be notified well in advance of any test in which the manufacturer's current production model will be compared with those of other manufacturers. The manufacturer shall be entitled to have his representative present during the test.	**4.4** It is recommended that the manufacturer be notified well in advance of any test in which the manufacturer's current production model will be compared with those of other manufacturers. The manufacturer shall be entitled to have his representative present during the test.	
3.5 The test may be conducted with a standardized test material such as uniform size spherical prills, a specific granular product or an inert product simulant. A description of the material including sieve size, moisture content, bulk density, and product name shall be specified in the test report (see ASAE Standard S281, Capacity Designation for Fertilizer and Pesticide Hoppers and Containers).	**4.5** The test may be conducted with a standardized test material such as uniform size spherical prills, a specific granular product or an inert product simulant. A description of the material including sieve size, moisture content, bulk density, and product name shall be specified in the test report (see ASAE Standard S281).	
3.5.1 Results of a sieve analysis shall be reported. The percent of material retained on each screen shall be stated. The sieves used shall conform to American National Standard Z23.1, Specifications for Wire-Cloth Sieves for Testing Purposes.	**4.5.1** Results of a sieve analysis shall be reported. The percent of material retained on each screen shall be stated. The sieves used shall conform to American National Standard Z23.1.	
3.5.2 A description of the test material's particle shape and surface texture shall be included in the test report.	**4.5.2** A description of the test material's particle shape and surface texture shall be included in the test report.	
SECTION 4 - TEST PROCEDURE	SECTION 5 - TEST PROCEDURE	
4.1 Guidelines for test setup **4.1.1** The accuracy of the test can be		

Current ASAE S341.2	Proposed Revision	Rationale
influenced by wind, granule or particle size, rate of application, ground slope, travel speed, ground roughness and method of collecting samples. The following recommendations should be followed to maintain test accuracy:	**5.1 Guidelines for test setup** **5.1.1** The accuracy of the test can be influenced by wind, granule or particle size, critical relative humidity of the product, rate of application, ground slope, travel speed, ground roughness, temperature, relative humidity, and method of collecting samples. Conducting tests on a hard surface can also affect the observed patterns. This effect is more pronounced as particle size increases. The following recommendations should be followed to maintain test accuracy:	Warnings on critical relative humidity of product, relative humidity, and temperature added. Warning on conducting test on hard surface added.
4.1.1.1 All spreading shall be done when the wind velocity is less than 8 km/h (5 mile/h) at a height of 2.5 m (5 ft) above the ground. If a wind exists, the direction of travel shall be parallel (within ± 15 deg) to the direction of the wind.	**5.1.1.1** All spreading shall be done when the wind velocity is less than 8 km/h (5 mile/h) at a height of 1.5 m (5 ft) above the ground. If a wind exists, the direction of travel shall be parallel (within ± 15 deg) to the direction of the wind.	Corrected metric conversion error.
4.1.1.2 Tests shall be conducted on a surface having a slope of less than 2%. If desired, the spreaders may also be tested on a sloping surface provided all spreaders in the comparison are tested on the same slope and the degree and direction of slope reported.	**5.1.1.2** Tests shall be conducted on a surface having a slope of less than 2%. If desired, the spreaders may also be tested on a sloping surface provided all spreaders in the comparison are tested on the same slope and the degree and direction of slope reported.	
4.1.1.3 The spreader should be operated for a period long enough for the flow or output to stabilize. This will vary with spreader design, however operating the spreader over a distance of 100 m (328 ft) is generally adequate.	**5.1.1.3** The spreader should be operated for a period long enough for the flow or output to stabilize. This will vary with spreader design; however, operating the spreader over a distance of 10 m (33 ft) is generally adequate.	Reduced length of preliminary run; 100 m is normally not required.
4.1.1.4 If the test results are to be used for the specific purpose of adjusting the field performance of an individual spreader, it is recommended that the test be conducted under field conditions that represent normal use. purpose of test	**5.1.1.4** If the test results are to be used for the specific purpose of adjusting the field performance of an individual spreader, it is recommended that the test be conducted under field conditions that represent normal use. This implies conducting the test on a surface similar to the field surface, since the effective swath width, rate, and pattern uniformity will be affected by particle bounce into the collection devices when tests are conducted on hard surfaces.	Included warning that test surface should match field surface and that hard test surface will cause particle bounce into collectors.
4.1.2 The spreader shall be filled the day of the test. A minimum of 10 min shall be allowed for settling before the test is conducted. If the test is not conducted within 4 h after filling, the spreader shall be emptied and refilled. **4.1.3** Tests shall be run with the spreader	**5.1.2** The spreader shall be filled the day of the test. If the test is not conducted within 4 h after	

Current ASAE S341.2	Proposed Revision	Rationale
hopper or box filled and leveled to 40-50% of capacity as defined by ASAE Standard S281, Capacity Designation for Fertilizer and Pesticide Hoppers and Containers.	filling, the spreader shall be emptied and refilled.	Settling of product is unnecessary.
	5.1.3 Tests shall be run with the spreader hopper or box filled and leveled to 40-50% of capacity as defined by ASAE Standard S281.	
4.2 Collection devices	**5.2 Collection devices**	
4.2.1 Width of each collecting tray (measured perpendicular to the direction of travel) shall not exceed 10% of the anticipated effective swath width. The length shall be equal to or greater than the width with a minimum length of 30 cm (1 ft). The maximum wall thickness of the tray sides shall be 2.3 mm (0.09 in.).	**5.2.1** Width of each collecting tray (measured perpendicular to the direction of travel) shall not exceed 10% of the anticipated effective swath width. The length shall be equal to or greater than the width with a minimum length of 30 cm (1 ft). The maximum wall thickness of the tray sides shall be 2.3 mm (0.09 in.).	
4.2.2 Trays should be of sufficient size to collect samples, from one pass of the spreader, that are large enough to accurately measure with available measuring equipment.	**5.2.2** Trays should be of sufficient size to collect samples, from one pass of the spreader, that are large enough to accurately measure with available measuring equipment.	
4.2.3 To decrease the possibility of particles ricocheting out of the trays, each tray should be divided into compartments. The maximum size of the compartments shall be 10 cm (4 in.) wide by 10 cm (4 in.) long. The minimum size of the compartments should be 5 cm (2.0 in.) by 5 cm (2.0 in.). The depth of the compartments shall be at least 50% of the maximum horizontal dimension. Precautions such as covering the tray floor with soft material may be taken if the granule being tested contains no small particles which may lodge in the covering material.	**5.2.3** To decrease the possibility of particles ricocheting out of the trays, each tray should be divided into compartments. The maximum size of the compartments shall be 10 cm (4 in.) wide by 10 cm (4 in.) long. The minimum size of the compartments should be 5 cm (2.0 in.) by 5 cm (2.0 in.). The depth of the compartments shall be at least 50% of the maximum horizontal dimension. Precautions such as covering the tray floor with soft material may be taken if the granule being tested contains no small particles which may lodge in the covering material.	
4.2.4 Sufficient trays shall be used to provide at least 10 trays within the effective swath width. Spacing of the trays shall be uniform, except that trays may be rearranged to allow passage of spreader and vehicle wheels. Additional trays shall be spaced out on either side of the effective swath width to a distance equal to at least 50% of the swath width.	**5.2.4** Sufficient trays shall be used to provide at least 10 trays within the effective swath width. Spacing of the trays shall be uniform, except that trays may be rearranged or omitted to allow passage of spreader and vehicle wheels. Additional trays shall be spaced out on either side of the anticipated effective swath width to a distance equal to at least 50% of the swath width on each side.	To clarify the placement of collectors in the vehicle area and to clarify the collectors needed outside the effective swath width. Since the effective swath is usually not known when laying out a test, the *anticipated* effective swath width
4.2.5 During all tests, the tops of the trays shall not be over 10 cm (4 in.) above the ground level with the spreader in the normal operating position. If the height of the discharge point on the spreader is less than 0.5 m (20 in.), the tops of the trays shall be less than 5 cm (2 in.) above	**5.2.5** During all tests, the tops of the trays shal'	

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the ground level.	not be over 10 cm (4 in.) above the ground level with the spreader in the normal operating position. If the height of the discharge point on the spreader is less than 0.5 m (20 in.), the tops of the trays shall not be over 5 cm (2 in.) above the ground level.	is specified.
4.2.6 Power take-off driven units shall be operated at the speed specified by the spreader manufacturer. If the specified speed is 540 ± 10 rpm or 1,000 ± 25 rpm (see ASAE Standard S203, Rear Power Take-Off for Agricultural Tractors) or other, it shall be noted in the test report. For truck-mounted units the spinner shall be rotated at the speed recommended by the manufacturer. For electrically driven units, supply voltage shall conform to that recommended by the manufacturer; any deviation shall be stated in the report.	**5.2.6** Power take-off driven units shall be operated at the speed specified by the spreader manufacturer. For truck-mounted units the spinner shall be rotated at the speed recommended by the manufacturer. For electrically driven units, supply voltage shall conform to that recommended by the manufacturer; any deviation shall be stated in the report.	Improved consistency of wording. Removed unnecessary wording.
4.2.7 Relative travel speed between the spreader and the collection trays shall be in the range recommended in the manufacturer's literature, and kept constant during the conduct of the test. The actual speed of the spreader and/or collection trays at which the tests were conducted shall be reported.	**5.2.7** Relative travel speed between the spreader and the collection trays shall be in the range recommended in the manufacturer's literature, and kept constant during the conduct of the test. The actual speed of the spreader and/or collection trays at which the tests were conducted shall be reported.	
4.3 Description of the test procedure. The test should consist of two parts: (1) determination of application rate and (2) determination of the distribution pattern by measurement of applied materials from suitable collectors. Each part of the test should be replicated to account for random variation.	**5.3 Description of the test procedure.** The test should consist of two parts: (1) determination of application rate and (2) determination of the distribution pattern by measurement of applied materials from collectors as specified in Section 5.2. Each part of the test should be replicated to account for random variation.	
4.4 Determination of application rates	**5.4 Determination of application rates**	
4.4.1 The preferred method of determining application rates is by measuring the amount of material exiting the spreader during operation over a known area.	**5.4.1** The preferred method of determining application rates is by measuring the amount of material exiting the spreader during operation over a known area.	
4.4.2 Weight of material applied can be determined by collecting and weighing spreader output while traveling a measured distance or weighing the spreader and its contents before and after spreading material over a known distance.	**5.4.2** Weight of material applied can be determined by collecting and weighing spreader output while traveling a measured distance or weighing the spreader and its contents before	
4.4.3 Using the methods described in paragraph 4.4.2, the application rate should be calculated as follows: R = QK/LW		

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where R = application rate, kg/ha (lb/acre) QQ = weight applied, kg (lb) L = distance spreader operated, m (ft) W = swath spacing, m (ft) K = constant, 10,000 (43,560)	and after spreading material over a known distance. **5.4.3** Using the methods described in paragraph 5.4.2, the application rate for a specific swath spacing should be calculated as follows: R = QK/LW where R = application rate, kg/ha (lb/acre) QQ = weight applied, kg (lb) L = distance spreader operated, m (ft) W = swath spacing, m (ft) K = constant, 10,000 (43,560)	To clarify that this calculation is dependent upon a known or assumed swath spacing.
4.4.4 An alternate method for determining application rate is by calculation from the amount of material collected in spread pattern tests (see paragraph 4.5.2). The accuracy of this method is influenced by collector design and type of surface around the collectors. If the collector surface is such that particles entering the collector bounce out, this method will yield rates that are lower than actual rates.	**5.4.4** An alternate method for determining application rate is by calculation from the amount of material collected in spread pattern tests (see paragraph 5.5.2). The accuracy of this method is influenced by collector design and type of surface around the collectors. If the collector surface is such that particles entering the collector bounce out, this method will yield rates that are lower than actual rates. If the test is conducted on a hard surface, it is more likely that granules will bounce into the collectors thus causing the apparent rate to be too high. This problem can be eliminated either by operating on a surface similar to the proposed field surface or by using collectors that prevent granules bouncing in *or* out.	Included warning about particles bouncing into collectors from hard test surface and added suggestions for alleviating problem.
4.4.5 Application rates based on material collected in spread pattern tests should be calculated using the following equation: R = KW/AE where R = application rate, kg/ha (lb/a) K = constant, 100,000 (13,829) W = sample weight, g A = area of collector opening, cm^2 (in^2) E = collector efficiency, 0% - 100%	**5.4.5** Application rates based on material collected in spread pattern tests can be calculated using the following equation (if the collector efficiency is not known, 100% must be assumed): R = KW/AE where	

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4.4.6 The volume (in cubic centimeters) of material collected in spreader pattern tests can be used to determine application rates. Using the bulk density of the material being applied (see ASAE Standard S281, Capacity Designation for Fertilizer and Pesticide Hoppers and Containers), the weight of material collected can be calculated by the following equation:

$$W = DV/K$$

where

W = weight, g
D = bulk density, kg/m^3 (lb/ft^3)
V = volume, cm^3
K = constant, 1,000 (62.4)

4.5 Spread pattern test
4.5.1 Spread pattern tests indicate the degree of uniformity of distribution of material across the swath being spread.
4.5.2 The spread pattern test shall be accomplished by operating the spreader in a line perpendicular to a line of collection trays spaced equally on the ground. An odd number of trays should be used, and the spreader should be driven astride the center pan. Material collected in each tray should be weighed or measured volumetrically.
4.5.3 The actual delivery rate and the spreader settings used to achieve these rates shall be reported. All spreaders to be compared shall be tested at the same rate, if possible. If field performance of an individual spreader is desired, the application rate shall be selected based upon the agronomic requirements of the test. Application rates of approximately 25, 50, and 75% of the maximum application rate for the test material are suggested if multiple rates

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R = application rate, kg/ha (lb/a)
K = constant, 100,000 (13,829)
W = sample mass,
A = area of collector opening, cm^2 (in^2)
E = collector efficiency, normally 0% - 100%, but can exceed 100% (expressed as a decimal in this equation)

5.4.6 The volume (in cubic centimeters) of material collected in spreader pattern tests can be used to determine application rates. Using the bulk density of the material being applied (see ASAE Standard S281), the weight of material collected can be calculated by the following equation:

$$W = DV/K$$

where

W = mass, g
D = bulk density, kg/m^3 (lb/ft^3)
V = volume, cm^3
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5.5.2 The spread pattern test shall be accomplished by operating the spreader in a line perpendicular to a line of collection trays spaced equally on the ground. An odd number of trays should be used, and the spreader should be driven astride the center pan. Material collected in each tray should be weighed or measured volumetrically.
5.5.3 The actual delivery rate and the spreader settings used to achieve these rates shall be reported. All spreaders to be compared shall b

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Changed to note that collector efficiency must be known to use this method. Often, it will *not* be known.

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are to be used. Additional tests may be conducted and reported at other rates selected from within the manufacturer's recommended range of application rates.	tested at the same rate, if possible. If field performance of an individual spreader is desired, the application rate shall be selected based upon the agronomic requirements of the test. Application rates of approximately 25, 50, and 75% of the maximum application rate for the test material are suggested if multiple rates are to be used. Additional tests may be conducted and reported at other rates selected from within the manufacturer's recommended range of application rates.	
4.5.4 Uniformity of distribution. The spreader tested shall be rated for uniformity of distribution. The coefficient of variation (CV) shall be used to determine and express the uniformity of distribution of applications. When overlapping of swaths occur, a simulated field application of multiple adjacent swaths shall be used to compute the CV. The simulated field distribution for each swath distribution pattern obtained in paragraph 4.5.2 is constructed by using the manufacturer's recommended swath width for the spreader being tested or the effective swath width (see paragraph 4.5.5) and accumulating the sample weights at each collection tray location. Individual replicates of the swath distribution pattern (not averages) shall be used. The method of spreading used shall be reported; i.e., either progressive (back and forth) or one direction (race track).	**5.5.4 Uniformity of distribution.** The spreader tested shall be rated for uniformity of distribution. The coefficient of variation (CV) shall be used to determine and express the uniformity of distribution of applications. When overlapping of swaths occur, a simulated field application of multiple adjacent swaths shall be used to compute the CV. The simulated field distribution for each swath width to be evaluated is constructed by accumulating the sample weights from the simulated overlapping swaths at each collection tray location. Individual replicates of the swath distribution pattern (not averages) shall be used. The method of spreading used shall be reported; i.e., either progressive (back and forth) or one direction (race track).	Reworded to clarify evaluation of alternate swath widths.
4.5.4.1 The mean value, standard deviation, and CV shall be determined as follows: $\text{Mean} = X = \Sigma X_i/N$ Standard deviation = $\{\Sigma[(X_i-X)^2]/(N-1)\}^{½}$ CV = (standard deviation)(100)/X	**5.5.4.1** The mean value, standard deviation, and CV shall be determined as follows: $\text{Mean} = X = \Sigma X_i/N$ Standard deviation = $\{\Sigma[(X_i-X)^2]/(N-1)\}^{½}$ CV = (standard deviation)(100)/X	
where X = arithmetic mean X_i = accumulated sample weight for each collector location for the overlapped swaths N = number of collector locations used	where	
4.5.4.2 Only the central portion of the simulated		

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or measured overlapped distribution data shall be used to compute the CV. If the swath spacing is equal to or greater than one-half of the total spread pattern width, this shall include data from one spreader centerline to the next for the one direction application method or the data from the centerline of the first swath to the centerline of the third adjacent swath for the progressive method. If the swath spacing is less than one-half of the total spread pattern width, additional overlapped distribution data shall be added until the region for calculation as indicated above would be unaffected by the addition of distribution data resulting from additional overlapping swaths. **4.5.5 Effective swath width.** The tests shall be run using the most effective swath width symmetrical about the centerline of travel.	X = arithmetic mean X_i = accumulated sample weight for each collector location for the overlapped swaths N = number of collector locations used **5.5.4.2** Only the central portion of the simulated or measured overlapped distribution data is needed to compute the CV. Regardless of application pattern, data from a width equal to the estimated (or trial) swath width is adequate. Data points equidistant from the center line to a distance halfway to the centerline of the next pass on each side shall be used. Data from enough adjacent swaths must be included so that the region for calculation as indicated above would be unaffected by the addition of distribution data resulting from additional overlapping swaths.	Simplified and clarified.
4.5.5.1 Frequently, the effective swath width will be the distance between the points on either side of a single swath where the rate of deposit equals one-half of the effective application rate. The effective swath width shall be determined in a manner which will give the most uniform overall application rate. The manufacturer's recommendation shall be used as a guide in determining the most effective swath width. **4.5.5.2** Another method for determining the effective swath width of the spreader is by inspecting values for CV, computed from simulated overlapped distribution data, versus swath width. Table 1 is a listing of CV's versus swath spacing and driving method. The largest swath width associated with the minimum acceptable CV shall be considered the effective swath width of the test.	**5.5.5 Effective swath width.** Data shall be reported on the most effective swath width symmetrical about the centerline of travel as well as any other trial swath widths used to determine this effective swath width. **5.5.5.1** Frequently, the effective swath width will be the distance between the points on either side of a single swath where the rate of deposit equals one-half of the effective application rate. The effective swath width shall be determined in a manner which will give the most uniform overall application rate. The manufacturer's recommendation shall be used as a guide in determining the most effective swath width.	Clarified to show that calculations on multiple trial swath widths are generally needed to obtain the effective swath width.
4.5.6 The results of this test may also be presented graphically as shown in Fig. 1. **4.5.6.1** In plotting test data the vertical axis shall indicate the application rate in kg/ha	**5.5.5.2** Another method for determining the effective swath width of the spreader is by inspecting values for CV, computed from simulated overlapped distribution data, versus swath width. Table 1 is an example listing of	

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(lb/acre or lb/1,000 ft^2) and the horizontal axis shall represent the spread width in m (ft). **4.5.6.2** The coefficient of variation and the setting at which it was determined shall be stated in each graph. **4.5.6.3** When indicating spreader overlap as shown in Fig. 1, it is necessary to report the method of spreading assumed; i.e. either progressive or one direction, and plot the graph accordingly.	CV's versus swath spacing and driving method. The largest swath width associated with the minimum acceptable CV shall be considered the effective swath width of the test. **5.5.6** The results of this test may also be presented graphically as shown in Fig. 1. **5.5.6.1** In plotting test data, the vertical axis shall indicate the application rate in kg/ha (lb/acre or lb/1,000 ft^2) and the horizontal axis shall represent the spread width in m (ft). **5.5.6.2** The coefficient of variation and the assumed width at which it was determined shall be stated. **5.5.6.3** When indicating spreader overlap as shown in Fig. 1, it is necessary to report the method of spreading assumed; i.e. either progressive or one direction, and plot the graph accordingly.	Clarified that Table 1 is an *example*. Changed to report width, not setting, and to allow noting in report, but not necessarily on the actual graph.
SECTION 5 - METHOD OF REPORTING RESULTS	SECTION 6 - METHOD OF REPORTING RESULTS	
5.1 If the test has been conducted as described by this Standard, the test results should be identified as follows: **5.1.1** The following note shall be place on each page on which test results appear: "These results have been obtained from a test made in accordance with ASAE Standard S341, Procedure for Measuring Distribution Uniformity and Calibrating Granular Broadcast Spreaders." **5.1.2** A descriptive statement shall be included in the report to explain the coefficient of variation. For example: This 18% variation means that at a setting of 100 kg/ha (89 lb/acre) the actual application rate would be expected to range between 82 and 118 kg/ha (73 to 105 lb/acre) on 68% of the area. **5.2** A brief description of the spreader shall precede the dimensions. If the spreader can be adjusted to deliver one side at a time (for headlands and row-crops), this should be mentioned. Adjustable spreader variables and their settings shall be reported. The following data should be included in the description: Type (centrifugal, pendulum, etc.) Manufacturer's name, model number, and year of manufacture: (Serial number if available) Minimum and maximum application	**6.1** If the test has been conducted as described by this Standard, the test results should be identified as follows: **6.1.1** A note in the report shall state: "These results have been obtained from a test made in accordance with ASAE Standard S341, Procedure for Measuring Distribution Uniformity and Calibrating Granular Broadcast Spreaders." **6.1.2** A descriptive statement shall be included in the report to explain the coefficient of variation. For example: This 18% variation means that at a setting of 100 kg/ha (89 lb/acre) the actual application rate would be expected to range between 82 and 118 kg/ha (73 to 105 lb/acre) on 68% of the area. **6.2** A brief description of the spreader shall precede the dimensions. If the spreader can be adjusted to deliver one side at a time (for headlands and row-crops), this should be mentioned. Adjustable spreader variables and	Deleted requirement that this statement appear on every page of the report.

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rates: kg/ha (lb/acre) Minimum and maximum output rates: kg/min (lb/min) Overall length: cm (in.) Overall height: cm (in.) Overall width: cm (in.) Height of particle release above ground level (in operation): cm (in.) Metering system used Number of spinners or delivery points Manufacturer's recommended spread width: m (ft) Hopper capacity: m^3 and kg (ft^3 and lb) Track width (c-to-c): cm (in.) Number of wheels	their settings shall be reported. The following data should be included in the description: Type (centrifugal, pendulum, etc.) Manufacturer's name, model number, and year of manufacture: (Serial number if available) Minimum and maximum application rates: kg/ha (lb/acre) Minimum and maximum output rates: kg/min (lb/min) Overall length: cm (in.) Overall height: cm (in.) Overall width: cm (in.) Height of particle release above ground level (in operation): cm (in.) Metering system used Number of spinners or delivery points Manufacturer's recommended spread width: m (ft) Hopper capacity: m^3 and kg (ft^3 and lb) Track width (c-to-c): cm (in.) Number of wheels	
5.3 All test results shall be stated as listed in paragraph 5.1 and include the following: Application rate as indicated by the rate setting Actual application rate and method used to measure actual rate Standard deviation (for each application rate) CV (for each application rate) Material tested (analysis, bulk density, moisture content) Forward travel speed Relative travel speed Effective swath width Information concerning exceptions or additions which are peculiar to this test Wind speed and direction relative to spreader line of travel (see paragraph 4.1.1.1)	**6.3** All test results shall be stated as listed in paragraph 6.1 and include the following: Application rate as indicated by the rate setting Actual application rate and method used to measure actual rate Standard deviation (for each application rate) CV (for each application rate) Material tested (sieve analysis, bulk density, moisture content, product name) Granule shape and surface texture Forward travel speed Relative travel speed Effective swath width Information concerning exceptions or additions which are peculiar to	

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	this test Wind speed and direction relative to spreader line of travel (see paragraph 5.1.1.1) Description of test surface Tractor pto or impeller speed	
Cited Standards: ANSI Z23.1, Specifications for Wire-Cloth Sieves for Testing Purposes ASAE S203, Rear Power Take-Off for Agricultural Tractors ASAE S281, Capacity Designation for Fertilizer Pesticide Hoppers and Containers ASAE S327, Terminology and Definitions for Agricultural Chemical Application		Changed to conform to paragraph 4.5.
Captions for Tables and Figures (tables and figures themselves remain unchanged):		Added to conform to paragraph 4.5.2.
TABLE 1 - CV VALUES FOR DIFFERENT SWATH SPACINGS AND DRIVING METHODS		
FIG. 1 - GRAPHICAL PRESENTATION OF SPREAD PATTERN - ONE-DIRECTION APPLICATION METHOD	**Captions for Tables and Figures (tables and figures themselves remain unchanged):**	Added Description of test surface to better inform users of test results of test conditions. Added to conform to paragraph 5.2.6.
	TABLE 1 - EXAMPLE OF CV VALUES FOR DIFFERENT SWATH SPACINGS AND DRIVING METHODS	
	FIG. 1 - GRAPHICAL PRESENTATION OF SPREAD PATTERN - ONE-DIRECTION APPLICATION METHOD	
		Clarified that this table is *example* data.

ENCLOSURE 3

CEN/TC 144/WG 3 N 167-1 E

CEN/TC 144/WG 3/AH 12 N 50-1 E

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Agricultural and forestry machinery – Full width distributors and broadcasters for solid fertilizer – Environmental preservation – Part 1: Requirements

This draft Europeean Standard is submitted to CEN/TC 144/WG 3 members for approval to be circulated as a prEN for the CEN enquiry.

It has been drawn up by CEN/TC 144 "Tractors and machinery for agriculture and forestry".

If this draft becomes an European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard are established by CEN in three official versions (English, French, German). A Version in any other language made by translation under the responsibility of a CEN member into its own languahe and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat : rue de Strassart 36, B-1050 Brussels

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0 Introduction

This European Standard has been prepared by WG 3 "Mobile machines and trailers" of CEN/TC 144 " Tractors and machinery for agriculture and forestry" of which the secretariat is held by AFNOR.

The objective with this standard is that the equipment should admit that:
- unintentional spreading of fertilizers into the surrounding environment is avoided and
- good control is achieved with the chosen input of fertilizer.

This standard does not include any direct requirements for the longitudinal distribution. The requirements for evenness of flow rate will partly cover that subject.

This standard consists of the following additional part, under the general title Agricultural and forestry machinery – Full width distributors and broadcasters for solid fertilizer – Environmental preservation

EN xxxx-2, Test methods.

1 Scope

This standard specifies requirements for the environmental safety for design and construction of mounted, trailed and self-propelled full width solid fertilizer distributors and solid fertilizer broadcasters used in agriculture and horticulture. It also gives the requirements for the minimum content of the instruction handbook.

The standard does not apply to machines with:
- combined grain and fertilizer drills or
- equipment for distributing granulated pesticides .

Personal safety aspects have not been considered in this standard.

If both full width distrubutors and broadcasters are ment the term machine will cover them both, except 'n the definitions.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revision of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to apply.

EN xxxx-2: 199x	Agricultural and forestry machinery – Full width distributors and broadcasters for solid fertilizer– Environmental preservation – Part 2: Test methods

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 **solid fertilizer distributor**: Machine which spreads fertilizer in a continuous way on the soil surface.

3.1.1 **solid full width fertilizer distributor**: Solid fertilizer distributor which spreads fertilizer over the whole surface and which has a working width which is roughly the same as the machine width.

3.1.2 **solid fertilizer broadcaster**: Solid fertilizer distributor which spreads fertilizer over the whole surface and which has a working width which is essentially wider than the machine width.

3.1.3 **solid fertilizer distributor in lines**: Solid fertilizer distributor which spreads fertilizer in bands separated by bands without fertilizer and which has a working width which is roughly the same as the machine width.

3.2 **combined grain and fertilizer drill**: Machine which simultaneously sows seed and places fertilizer on the same drive.

3.3 **fertilizer limit**: The point from where fertilizer is found continuously

3.4 **working width**: Distance between two adjacents tramlines.

3.5 **throwing width:** Distance between the left and the right end of a transversal distribution.

3.6 **border throwing width**: The distance between the centre of the distributor (edge tramline) to the fertilizer limit, see figure 1

3.7 **edge width**: The first five meters from the fertilizer limit, see figure 1.

3.8 **transition width**: The distance from the end of the edge width to the centre between the first and second tramline as given in figure 1.

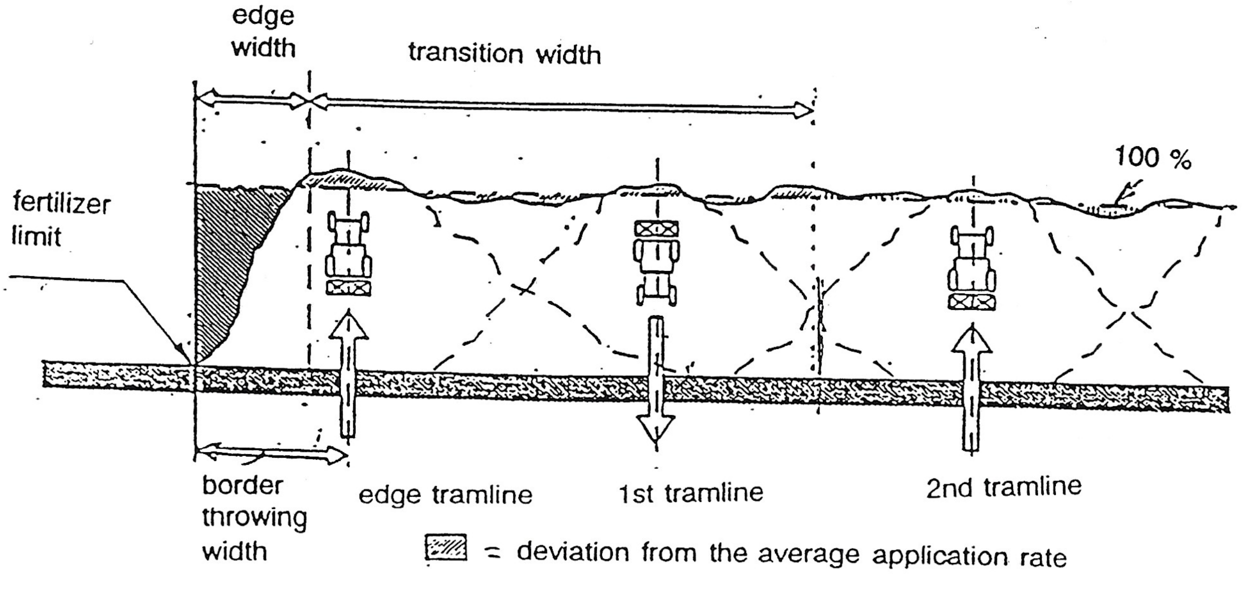

Figure 1 : Definition of transition width and border width

3.9 **application rate**: The weight of solid fertilizer applied per unit area, expressed as kg/ha.

3.10 **flow rate**: Amount of solid fertilizer leaving the feeding system, expressed in kg/min.

> NOTE – The relation between the flow rate and the application rate is given by the following formula:
> Total flow rate (kg/min) = [Application rate (kg/ha) x traveling speed (km/h) x working width(m)] :600

3.10.1 **intended flow rate**: Flow rate wished by the user.

3.10.2 **set flow rate:** Selected flow rate, set with the machine control.

3.10.3 **calibrated flow rate**: A flow rate based on an instantaneous measurement and calculations, made with the machine calibration aids.

3.10.4 **obtained flow rate**: Flow rate given by the machine for a certain machine control setting.

3.11 **spillage:** Fertilizer which falls, is thrown, uncontrolled from the machine to the ground when the feeding device is disengaged.

4 Requirements

The machine shall be designed to allow easy handling and adjustments for different types of fertilizers to be used, in order to ensure that the chosen amount of fertilizer per area is spread evenly and in the area for which it is aimed. The machine shall fulfil at least the requirements given 4.1 up to 4.11.

> NOTE : The manufacturer must also take in consideration that the machine may work in a corrosive environment.

4.1 Hopper filling opening

The machine shall be designed to minimize the risk that undesirable materials will cause blockages and influence the flow rate or the distribution spreading pattern in a negative way. This can for example be achieved by a grid.

4.2 Cleaning and emptying of residuals

Emptying and collecting the fertilizer from the hopper shall be possible without spreading and without unintentional flow to the ground. If tools are necessary to empty the hopper they shall be delivered with the machine and a place shall be provided on the machine for their storage.

It shall be possible for a person, standing on the ground or on the existing access means to clean the machine.

4.3 Contact with obstacles

On a full width distributor with a working width more than 10 m the outer end of the boom shall be able to move backwards in case of contact with obstacles in the field. If the full width distributor is moved forwards with 4 km/h and the obstacle is within 90% to 100% of half the boom width measured from the middle of the track, see figure 2, the boom or sections of the boom must be able to

The adjustment of the feeding system from the previous flow rate to the new flow rate must occur within 5 s when adjusting the flow rate by ± 50 % from the original flow rate.

4.7 Feeding device

The control(s) (e.g. lever, switches, e.t.c.) of the feed mechanism shall have a clearly marked on and off position related to opened and closed feed mechanism. This marking can be replaced by an indicator showing the operator at the driver´s position, whether the feed mechanism is on or off.

4.8 Tightness

With the feeding device closed no spillage shall occur from the filled distributor to the ground during transport.

4.9 Evenness of transversal distribution

4.9.1 Field spreading

The evenness of the transversal distribution for fertilizer distributors shall be such that the calculated value of the coefficient of variation, when driving to and fro, does not exceed 15% calculated in accordance with EN xxxx–2. This requirement shall be met for all stated conditions (e.g. working widths and fertilizer type) except for boarding spreading.

4.9.2 Field edge (border) spreading

Machines shall be possible to use for field edge spreading, with or without extra equipment.

At no point within the edge width shall the application rate exceed the average application rate found, when testing according to 4.9.1, by more than 20 %.

he coefficient for the transition width, CT, shall not exceed 20 % calculated in accordance with EN xxxx–2.

4.9.3 Top–dressing

For equipment and/or adjustments for spreading fertilizer in a high crop the coefficient of variation for the evenness of transversal distribution shall not exceed the coefficient of variation for the evenness of distribution as defined in 4.9.1 and 4.9.2.

4.10 Setting of flow rate

4.10.1 For the fertilizers listed in the instruction handbook it shall be possible to set the flow rate in the range between the stated maximum and minimum flow rates

4.10.2 It shall be possible to set the flow rate to an intended flow rate within a max deviation as given in table 1.

give away without being damaged.

If the machine is not design to be used at a so low speed the same requirement shall be valid for a forward speed of 8 km/h.

The boom sections shall return automatically to their original position after contact with the obstacle.

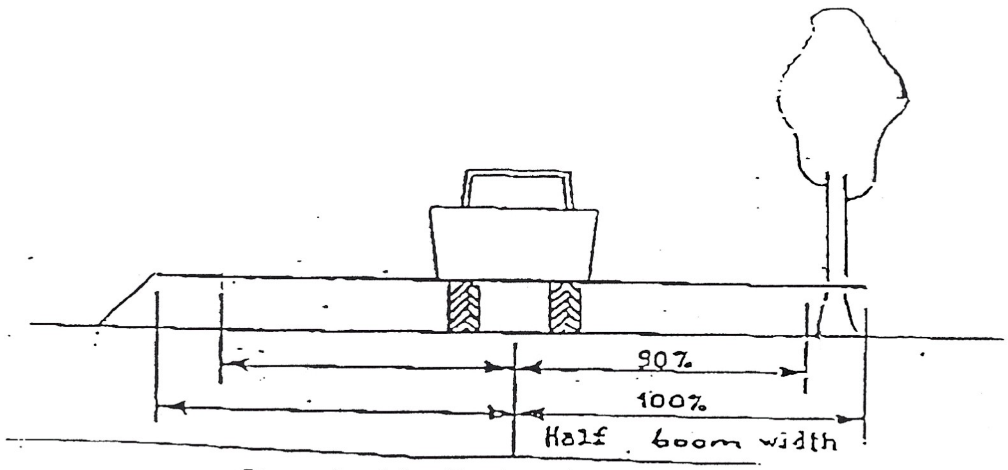

Figure 2 – Identification of boom width

4.4 **Filling grade control**

The basic-hopper of the machine (e.g. the hopper without any extension walls), shall be fitted with a scale by which (after levelling the fertilizer) the volume of fertilizer in the hopper can be estimated. The scale shall cover at least 10 % to 80 % of the basic-hopper volume and have a graduation for at least each 10 % of the nominal volume of the basic-hopper. The accuracy of the graduations shall be within ± 10 % of the reading.

4.5 **Adjustmentof flow rate**

4.5.1 Relevant calibration aids for the flow rates, shall be supplied together with the machine.

4.5.2 If the machine is fitted with a system which allows a fast decrease or increase of the flow rate, then this variation range shall be at least ± 20% of the set flow rate, not exceeding the limit values defined in 4.11. It shall be possible to do the adjustment stepless or in steps of maximum 10% of the set flow rate.

4.5.3 It shall be possible to adjust the machine to a different working width (for example to a reduced working width) and for field edge spreading even when the hopper is filled with fertilizer.

4.6 Flow rate regulation system

If the machine is fitted with a system, which controls the flow rate, the obtained application rate shall be within ± 7 % of the intended application rate, whatever the type of regulation is (speed, working width and application rate). This requirement is checked by measuring the flow rates.

The transversal distribution before and after the regulation shall fulfil the requirement of 4.9.1.

The adjustment of the feeding system from the previous flow rate to the new flow rate must occur within 5 s when adjusting the flow rate by ± 50 % from the original flow rate.

4.7 Feeding device

The control(s) (e.g. lever, switches, e.t.c.) of the feed mechanism shall have a clearly marked on and off position related to opened and closed feed mechanism. This marking can be replaced by an indicator showing the operator at the driver´s position, whether the feed mechanism is on or off.

4.8 Tightness

With the feeding device closed no spillage shall occur from the filled distributor to the ground during transport.

4.9 Evenness of transversal distribution

4.9.1 Field spreading

The evenness of the transversal distribution for fertilizer distributors shall be such that the calculated value of the coefficient of variation, when driving to and fro, does not exceed 15% calculated in accordance with EN xxxx-2. This requirement shall be met for all stated conditions (e.g. working widths and fertilizer type) except for boarding spreading.

4.9.2 Field edge (border) spreading

Machines shall be possible to use for field edge spreading, with or without extra equipment.

At no point within the edge width shall the application rate exceed the average application rate found, when testing according to 4.9.1, by more than 20 %.

he coefficient for the transition width, CT, shall not exceed 20 % calculated in accordance with EN xxxx-2.

4.9.3 Top-dressing

For equipment and/or adjustments for spreading fertilizer in a high crop the coefficient of variation for the evenness of transversal distribution shall not exceed the coefficient of variation for the evenness of distribution as defined in 4.9.1 and 4.9.2.

4.10 Setting of flow rate

4.10.1 For the fertilizers listed in the instruction handbook it shall be possible to set the flow rate in the range between the stated maximum and minimum flow rates

4.10.2 It shall be possible to set the flow rate to an intended flow rate within a max deviation as given in table 1.

Table 1 : Max allowed deviation between set flow rate and intended flow rate

Set flow rate (kg/min)	Max allowed deviation in % of intended flow rate
< 25	15
25 – 150	10
> 150	7.5

4.10.3 The obtained flow rate during spreading shall be the same as the calibrated flow rate with a maximum allowed deviation of ±10 % of the calibrated flow rate, measured in accordance with EN xxxx–2.

4.11 Evenness of flow rate

During emptying the deviation in the obtained flow rate shall not exceed the values in table 2. The requirement shall be fullfilled with the hopper filled to all levels above 5 % of the capacity for the basic hopper volume.

Table 2 : Maximum allowed deviation in obtained flow rate

Average obtained flow rate (kg/min)	Max allowed deviation in % of the average obtained flow rate
< 25	10
25 – 150	7,5
> 150	5

5 Instruction handbook

An instruction handbook shall be delivered with the machine. The text shall be in one of the official languages of the country to which the distributor is sold.

The instruction handbook shall be such that it does not deteriorate when kept on the machine and during normal use. The information could also be durable marks on the machine.

The instruction handbook shall contain at least the points listed below. If the figures given varies with the type of fertilizer used the information shall be extended to each type of fertilizer:

- a description of the machine´s function and of its proper use;
- a list of the types of fertilizer which are suitable for the machine;
- a describtion of handling, care and maintenance of the machine which enable the driver to adjust, check and use it as it is intended to operate, including actions to be taken before reading the hopper volume scale;

NOTE: All information for the adjustment of the distributor can also be given on the machine.

- instructions about the risk for corrosion and how to reduce it, including recommendations on when to change vital parts due to wear and corrosion;
- an explanation about the relationship between the traveling speed and the application rate, including instructions for checking the flow rate or for landdriven machines thc application rate.;
- the means to influence the fertilizer distribution (spreading pattern), i.c. more/less in the middle of the spreading pattern respectively more/less in the range of overlap of thc spreading pattern;
- the possible working widths and instructions how to get a different working width (normal and reduced);
- the distance of the border throwing width;
- the maximum rearward throwing length for different working widths.

No agreement was found concerning the necessity to keep or not the parameters below. It was therefor left to WG 3 to decide.

- the distance between the spreading device and the point where the maximum amount of fertilizer can be found;
- the distance between the spreading device and the border where the headland and the other field meets, to get an optimum overlap spreading when driving both to and fro the headland;

NOTE : The information on these distances could preferable be shown in a diagram;

6 Verification

The test methods to be used for the verification of the requirements in clause 4 shall be as listed in table 3 Also the content of the instruction handbook has to be checked as listed in table 3.

Table 3 – Test methods for verifying different requirements

Requirements		Test method		References
Clause	Quality	Inspection	Function test	
4.1	Hopper filling opening	X		
4.2	Hopper cleaning and emptying	X		
4.3	Contact with obstacles		X	
4.4	Filling grade control		X	
4.5.1	Calibration aids	X		
4.5.2	Adjustment of flow rate		X	
4.5.3	Reduced working width		X	
4.6	Flow rate regulation systems		X	
4.7	Feeding device	X		
4.8	Tightness	X		
4.9.1	Eveness of transversal distribution for field spreading		X	
4.9.2	Eveness of transversal distribution for field edge (border) spreading		X	
4.9.3	Eveness of transversal distribution for top dressing		X	
4.10.2	Deviation between set and intended flow rates		X	
4.10.3	Deviation between obtained and calibrated flow rates		X	
4.11	Evenness of flow rate		X	
5	Instruction handbook	X		

ANNEX A (informative)
Checklist for the instruction handbook for full width distributors and broadcasters

A.1 Specifications

* Make
* Type
* Identification number
* Weight of the machine (empty)
* Max permissible load on the machine (fully loaded)
* Max weight on each axis for a fully loaded, trailed machine
* Max weight on the tractor's drawbar for a fully loaded, trailed machine
* Name and address of manufacturer

A.2 Description of function

* Symbols
* Specifications of maximum rearward throwing length and lateral (left and right) throwing width.
* Tyre pressure for the machine tyres
* Specifications of extra tyre and wheel equipment (including recommended tyre pressures for these)
* Description of the agitator device

A.3 Description of adjustments

* Adjustment of the machine height relative to the ground or the crop
* Adjustment of the machine inclination in relation to the horizontal plane
* Instructions on how to fill the machine to obtain an even distribution
* How to prevent spillage during transport
* Application rate tables, selection of forward speed and diagrams showing the distribution pattern (principals)
* Settings for different types of application rates, types of fertilizer and other factors that affect the result of the distribution
* Adjusting of the working width
* How to set field-related application rates

A.4 Function checks

* Calibration test for checking the application rate
* Field test for checking the application rate
* How to use special equipment when performing field tests
* Checking the rotational frequency
* Checking the machine inclination and its height above the ground

A.5 Advice on driving technique

* Driving technique on the field and the headland and for the laps.
* Interrupted spreading in case of too high wind velocities
* Use of permanent tramlines or other methods for keeping constant distance to the adjacent lap
* Turning on and shutting off the machine on the headlands
* Driving close to the field edge
* Spreading with partial shut–off

A.6 Operation and maintenance

* Cleaning the inside and outside of the machine
* Lubrication, greasing and change of oil
* Corrosion–resistance
* Necessary checks on wear and corrosion (wear limits) on all parts that are significant for the spreading results
* Repairs and changing of worn–down parts: power shafts, transporters, spreading mechanisms, seals etc.
* Specify what repairs ought to be done by the manufacturer/dealer

A.7 Technical specifications of the machine

CEN/TC 144/WG 3 N 167-2 E

CEN/TC 144/WG 3/AH 12 N 50-2 E

EUROPEAN STANDARD

NORME EUROPEENNE

EUROPÄISCHE NORM

DRAFT

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April 1996

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Descriptors:

English version

Agricultural and forestry machinery – Full width distributors and broadcasters for solid fertilizer – Environmental preservation – Part 2: Test methods

This draft Europeean Standard is submitted to CEN/TC 144/WG 3 members for approval to be circulated as a prEN for the CEN enquiry.

It has been drawn up by CEN/TC 144 "Tractors and machinery for agriculture and forestry".

If this draft becomes an European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard are established by CEN in three official versions (English, French, German). A Version in any other language made by translation under the responsibility of a CEN member into its own languahe and notified to the Central Secretariat has the same status as the official ..rsions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat : rue de Strassart 36, B–1050 Brussels

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0 Forward

This European Standard has been prepared by WG 3 "Mobile machines and trailers" of CEN/TC 144 "Tractors and machinery for agriculture and forestry" of which the secretariat is held by AFNOR.

This standard consists of the following additional part, under the general title:
Agriculture and forestry machines – Full width distributors and broadcasters for solid fertilizer– Environmental preservation:

EN xxxx–1, Requirements.

The annex A concerns guidance how to identify the physical properties of fertilizer used in the test. The annex B is an example formats for test reports.

1 Scope

This standard specifies methods to test mounted, trailed and self–propelled full width solid fertilizer distributors and broadcasters used in agriculture and horticulture.

The standard does not apply to machines with:
- combined grain and fertilizer drills or
- equipment for distributing granulated pesticides

If both full width distrubutors and broadcasters are ment the term machine will cover them both.

2 Normative references

This European Standard incorporates by dated or undated reference, provisons from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revision of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN xxx–1: 199x Agricultural and foresty machines – Full width distributors and broadcasters for solid fertilizer – Environmental preservation – Part 1: Requirements

3 Definitions

For the purpose of this standard the definitions in EN xxxx–1 applies:

4 Test conditions

4.1 Machine for test

During the tests the machine shall be used according to the instruction handbook.
The rotational frequency used in the tests shall be noted in the test report.

In the test the machine shall be driven with a forward test speed which does not variate by more than ± 0,1 km/h and which is within the range of 4 km/h ±0,4 km/h.

The number of runs for each measurements shall be two

The flow adjustment shall be set to correspond to a forward driving speed of 8 km/h.

If the machine is not designed to be used at a forward speed of 4 km/h the forward test speed shall be within the range of 8 km/h ± 0,4 km/h and the number of runs shall be four. The test speed shall also in this case not variate by more than ± 0,1 km/h.

The forward test and driving speeds used shall be stated in the test report.

The distributing mechanism shall be at the height above the fertilizer–collecting containers (the upper edge of the containers) as recommended by the manufacturer for work above ground or crop.

4.2 Test materials

Unless the instruction handbook states otherwise the following test materials shall be used:

a) a granular material
- bulk density > 0,9 kg/dm3
- bulk density ≤ 0,9 kg/dm3

b) a prilled material
- bulk density > 0,9 kg/dm3
- bulk density ≤ 0,9 kg/dm3

c) a compacted material

d) a crystalline material

The physical properties for the test materials to be used shall be within the limits given in table A.1.

The physical properties of the test materials used shall be specified in the test report.

4.3 Application rates

Unless the instruction handbook states otherwise the following adjustments shall be used:

rate 1: a flow rate corresponding to a minimum application rate for the test material depending on the nutrient content, according to table 1;

rate 2: a flow rate corresponding to a maximum application rate for the test material depending on the nutrient content , according to table 1;

rate 3: a flow rate in between, corresponding to (rate 1 + rate 2) : 2

The machine shall be adjusted to give the flow rate within ± 5 kg/min .

Table 1 : Minimum and maximum application rate depending on nutrient content

Nutrient	Application rate kg/ha min	max
N	20	120
P_2O_5 (P)	30 (13)	150 (65)
K_2O (K)	40 (33)	300 (249)
MgO (Mg)	25 (15)	100 (60)
CaO (Ca)	200 (143)	1000 (715)
NOTE : The application rate (kg/ha) is calculated on the basis of the nitrogen (N) content for the test materials which includes nitrogen and on the basis of the phosphor (P) content for test materials which includes phosphor but no nitrogen.		

5 Test equipment

5.1 Accuracy in weighing measurements

The minimum accuracy for the samples of test materials shall be:

± 0,1 g for clauses: 6.6; 6.7; 6.8; 6.12
± 1,0 g for clauses: 6.5.2
± 500 g for clauses: 6.2; 6.3; 6.5.1; 6.9; 6.10; 6.11

5.2 Devices for receiving fertilizer for transversal distribution and rearward throwing length

The collecting containers shall have top external dimensions of 500 mm x 500 mm and precautions shall be taken to minimize spillage by ricochet into or out of the containers.

NOTE: The wall thickness at the top edge should be equal or smaller than 1,5 mm. An example of a funnelshaped container is shown in figure B.1. The container can also be like a box.
Test collecting containers with external top dimensions of 250 mm x 500 mm could be used if their amount is put together two and two. Existing collecting containers of 250 mm x 1000 mm could be used since it has been shown that the result corresponds to the 500 mm x 500 mm containers.

90% to 110 % of the expected amount of test materials shall be collected.
This requirement is checked by comparing the application rate calculated from the collecting containers with the application rate obtained in the flow rate test, when using test material from the same batch in the both measurements.

5.3 Test site

The tests shall be carried out on an even, horizontal and hard surface. The air velocity shall be less than 2 m/s during the tests. The air humidity shall be less than 65 % and the temperature less than 25° C.

The actual values of air humidity, temperature and air velocity shall be stated in the test report. If tests are done outdoors this shall also be stated in the test report.

Precautions shall be taken to eliminate ricochets into and out of the collecting containers.

5.4 Handeling of test materials during the tests

It is important that the test material is not exposed more to the air than neccesary. The maximum exposure time is 4 hours.

NOTE: All samples, for example for analysis of physical properties, should be immediately put under airtight storage.

6 Test methods

6.1 Contact with obstacles

For machines equipped with a boom:

An obstacle is placed along a horizontal test track. The machine is moved forward with the selected speed, according to 4.1. The boom shall hit the obstacle at 90 % to 100 % of the half boom width out from the middle of the track (see figure 2 in EN xxxx−1).

The boom movement is observed during the test. After the test the boom section is inspected any damages and positions are noted in the test report.

6.2 Filling scale control

The amount of test material in the hopper is estimated with water.

If not stated otherwise in the instruction handbook, when estimating the amount in the hopper the machine shall be placed horizontal. The hopper filled between 10 % to 80 % of the basic−hopper volume. The test shall be performed three times: one at the 10 % filling level, one at the 45 % filling level and one at the 80 % filling level.

The hopper shall first be made watertight and then filled with water. The volume of the water put into the hopper shall be noted as well as the volume indicated by the hopper scale. The deviation in % between the volume of water put into the hopper and the indicated volume shall be calculated and noted.

6.3 Adjustment of flow rate

If the machine has a system for fast decrease or increase of the flow rate then the system shall be tested at + 20 % and at − 20 % of flow rate 3. The test shall be performed with a granular test material.

Test samples shall be taken during a time which corresponds to a collecting of at least 50 kg.

6.6 Evenness of transversal distribution

6.6.1 Arrangement of containers

Containers (see 5.2.) shall be placed in a row side by side with their top edges parallel to the ground surface and shall cover at least the total throwing width. The row of containers shall be perpendicular to the direction of travel. Arrange the containers so that the center of the machine moves between the two collectors which represent the first container on right and left side.

> NOTE: The influence of for example tractor wheels when passaging over the containers must be minimized.

6.6.2 Procedure

Either the distributor or the collecting containers shall be in motion.

Arrange and adjust the machine according to the manufacturers instructions. Carry out the test with the machine adjusted for a speed according to 4.1 and note the adjustments in the test report.

If the test speed is different from the set speed the application rate collected from the containers shall be calculated by multiplying with x/y, where x is the actual speed and y is the speed which the flow rate is adjusted for. The application rate collected shall also be corrected for the number of runs, specified in 4.1.

The hopper shall be filled to at least 25 % of the stated basic hopper volume, or the minimum 500 l during the whole test.

The tests shall be carried out with the six test materials specified in 4.2 and for each material, at the three flow rates, as specified in 4.3. Tests shall also be performed for each of the six test materials at + 20 % and – 20 % of flow rate 3. if the distributor is fitted with a regulation system. ?

Weigh the test material collected in each container and calculate the coefficient of variation (CV) according to 7.1.3.

The test shall be carried out at the maximum and the minimum stated working widths. If the difference between minimum and maximum working widths is 6 meters or more then also test at working widths between minimum and maximum working widths. The difference between each tested working width shall be equal and not more than 6 m.

The test can be repeated twice. Any adjustments performed shall be in accordance with the instruction handbook. The test resulting in the lowest CV is to be noted in the test report together with the corresponding adjustments.

6.7 Evenness of transversal distribution near the field edge

Arrange and adjust the machine according to the manufacturers instructions for border spreading. Each adjustment and border spreading equipment shall be tested with test materials from one of the groups which were selected for the tests in 6.6, and with the rates 1, 2 and 3.

Perform the tests according to 6.6.

If the border throwing width varies (shown by the stated values) with the type of test material used and/or chosen working width, diverging border throwing widths shall be tested. In the latest case tests

The deviation in the obtained rate is calculated in % of the set flow rate and the result is noted in the test report.

NOTE: The test could be performed during the test of flow rate in 6.11.

6.4 Reduced working width

The possibilities to reduce the working width and adjustment for field edge spreading shall be checked with the hopper filled to at least 25 % of the basic hopper volume with a granular test material and:

1) the working width is reduced symmetrically from the tested working width to the smallest stated reduced working width.

2) the spreader is adjusted according to the manufacturers instruction for field edge spreading.

NOTE: The inspections could be done in 6.9 or 6.10. Points 1) and 2) can be done during the test of 6.6.

6.5 Flow rate regulation system (when available)

6.5.1 Deviations of the set flow rate

First calibrate the machine with a granular test material and to the specified flow rate 3.

Fill the basic hopper to at least 25 % of the basic hopper volume.

Find out which parameters can influence the regulation system and regulate the flow by using one parameter at the time according to:

- change in speed + 20 % and – 20% of average recommended speed
- change in application rate + 20 % and – 20 % of the stated flow above
- reduce working width, to the smallest reduced working width of the tested working widths

Both positive and negative deviations are measured by collecting all test material with at least 50 kg for each sample. For each parameter tested two measurements shall be made.

Calculate and note in the test report the deviations in percent from each calibrated flow rate.

Repeat the test as described above with the same test material but for the flow rates 1 and 2.

6.5.2 Continuous massflow measurements

Arrange the measurement equipment so that at least 50 % of the machine´s total massflow is measured continuously with the same type of test mateial as in 6.5.1.

Measure the massflow expressed as kg/s during the test series 1, 2 and 3 as described in 6.5.1.

Measure and note in the test report the time from initiation of change in flowrate to the achievement of maximum permitted deviation from set value. See figure 1.

shall be performed with another test material of those selected for the tests in 6.6 and with the flow rate 3.

Calculate the maximum deviation in the edge width from the average application rate, calculated in 6.8 for the test material used. Calculate the coefficient of variation in the transition width (CT). Use the results from 6.6 to add to the transversal border distribution when calculating CT.

NOTE: The border width and transition width is explained in figure 1 of EN xxxx.

6.8 Evenness of transversal distribution when spreading with equipment for top-dressing

Equipment and/or adjustments for top-dressing shall be tested for the flow rates 1 and 3 and a granular test material containing nitrogen, from one of the groups selected for the tests in 6.6. The test shall be performed when top-dressing at normal spreading and spreading near the field edge.

The method of testing is to use the equipment and method according to 6.6 and 6.7 except for the height adjustment of the *machine* which shall be the same height between the collecting container´s upper edge and the spreading devices as stated by the manufacturer shall be between the top of the crop and the spreading devices.

6.9 Deviation from intended flow rates

The test shall be performed with one test material selected for the tests in 6.6 and with the flow rates 1, 2 and 3.

Set the flow rate as close as possible to the intended flow rate by using the calibration method in 6.10. Perform as in 6.10 two longer flow rate tests.

The deviations between the obtained flow rates and the intended flow rate are calculated.

6.10 Deviation from calibrated flow rate

The test shall be performed with one test material from those selected in 6.6 and at the specified flow rates 1, 2 and 3 and calculated for a speed of 8 km/h and with the average of the stated working widths.

Searching of the intended flow rate (correct application rate) shall be done according to the manufacturers instructions. If the obtained flow rate deviates not more than ± 7 % from the intended flow rate the adjustment is received. At this set flow rate five separate calibration tests are performed. The average value is calculated.

Then two longer flow rate tests shall be performed with the same type of test material and with a sample size of at least 50 kg of test material.

The average calibration value shall be compared with the *longer* flow rate tests by calculating the deviation.

6.11 Evenness of flow rate

6.11.1 Flow rate on horizontal ground

The test is carried out with the test material as selected for the test in 6.6. The basic hopper shall be filled to its maximum stated volume.

Adjust the feed setting so as to obtain a flow as near as possible to 0,1 kg/s per metre of distribution width.

Start up the feed mechanism.

The test shall be performed with continuous massflow measurements or take samples of at least 50 kg. Take at least five recordings with steps at regular intervals of 15 % to 20 % of maximum load capacity during emptying. The last recording shall be finished at the 5 % level of the capacity for the basic hopper volume. Calculate in each recording the deviation from the set flow rate.

6.11.2 *Flow rate on sloping ground*

Perform as for 6.11.1 but on a surface with inclination angles of 10 degrees upwards, downwards and to either side, respectively.

The flow from each feeding device shall be measured separately. If the spreader has more than one feeder, at least two parts of the total flow shall be tested. The flows shall be chosen so that each one of them supplies a spreading device on each side of the spreader.

Compare the total flow with the results in 6.11.1 for the same test material. Compare the at least two measured flows at each side of the spreader with each other.

(Depending on decision for the instruction handbook)

6.12 Rearward throwing length

6.12.1 Arrangment of containers

Arrange the containers side by side in a row parallell to the line of travel of the distributor. The length of the row shall be 10 m or more in multiples of 10 m.

6.12.2 Procedure

Arrange the center of the distributors spreading device over the first wall of the first container in the row.

Using one of the test materials as selected for the tests in 6.8, adjust the spreader to specified flow rate 2.

If the total row length is not long enough to measure the whole reaward throwing length, the following principle should be used.

Start spreading test material with the spreader standing still during 20 seconds. Stop spreading and weigh the content of the containers. Move the spreader one container row length forward and continue the procedure. This is done until no test material collected in the row of containers.

Prepare for example a continuous diagram showing rearward throwing length backwards. See the graph in figure 3. Calculate the distance from the center of spreading device to where the maximum and zero amount of test material is reached.

Compare the test result with the stated values in the instruction handbook and if the reaward throwing length varies with the type of fertilizer, all six test material shall be tested at specified rate 2. If the results varies with different adjusted working widths, the test station shall at random choose two different working widths to test.

7 Calculation and presentation of test results

7.1 Transversal distribution

7.1.1 *Weighing*

Weigh the quantities collected in each container separately. Divide each of these values by the number of runs in order to determine the mean quantity distributed per run, and illustrate the distribution using a histogram. See the graph in figure 2.

7.1.2 *Working width*

The overlapped distribution shall be determined for the tested working width by using the histogram (see 7.1.1.). This shall be established by using the method for to and fro distribution, superposition by translation of the histogram with its mirror image. The coefficient of variation is calculated according to 7.1.3.

Present also the graph with the coefficient of variation as a function of the working width. In the graph–text the application rate and typ of fertilizer shall be noted.

If the setting of the distributor in another than recommended in the instruction handbook this must be noted in the test report.

7.1.3 *Degree of unevenness of transversal distribution*

The coefficient of variation, CV (%) is given by the equation:

$$CV = (s/\overline{x}) \cdot 100$$

where

s is the standard deviation, given by the equation:

$$s = \sqrt{\frac{1}{n-1}\sum (x_i - \overline{x})^2}$$

in which

n is the number of containers;
x_i is the amount collected in each container, in grams;
$\bar{x}$ is the average amount of collected fertilizer, in grams, after overlapping to and fro, given by the equation:

$$\overline{x} = \frac{1}{n}\sum x_i$$

7.1.4 *Equipment for spreading near the field edge*

For all machine types present the results in accordance to 7.1.1.

Calculate the maximum positive deviation in the transverse distribution in the edge width and compare it with the average application rate received in 7.1.2. and 7.1.3. (the same test material and adjusted application rate).

Calculate the coefficient CT for the transition width.

CT (%) is given by the equation:

$$CT = s_T / \overline{x}_N \cdot 100$$

where

$\bar{x}_N$ is the average calculated amount of fertilizer, in grams, after overlapping to and fro during normal transversal distribution, with the same type of fertilizer;
S_T is the standard deviation in the transition width and given by the equation:

$$S_T = \sqrt{\frac{1}{n_T - 1} \sum (X_{iT} - \overline{X}_T)^2}$$

in wich

n_T is the total number of containers in the transition width
X_{iT} is the calculated amount in each container in the transition width, in grams. Each amount is calcultated by combining an overlapped distribution of field edge spreading and normal spreading, see also figure 1 of EN XX
$\bar{x}_T$ is the average calculated amount of fertilizer, in grams in the transition width, given by the equation:

$$\overline{X}_T = \frac{1}{n} \sum X_{iT}$$

7.1.5 Top-dressing

Calculate and present the results in accordance with 7.1.1. to 7.1.3.

7.2 Flow rate

7.2.1 Flow rate on horizontal ground

Calculate in each recording the deviation from the set flow rate.
Note the maximum deviation from the set flow rate in the test report.

7.2.2 Flow rate on sloping ground

Calculate the results in accordance to 7.2.2. for each slope.
Calculate also the difference between the at least two measured flows for each slope.

Calculate the deviation between the total flow from each slope and the total flow on horisontal ground.

7.3 Rearward throwing length

Calculate and present the results according to 6.12.2.

8 Test report

A typical model of a test report is shown in annex B.

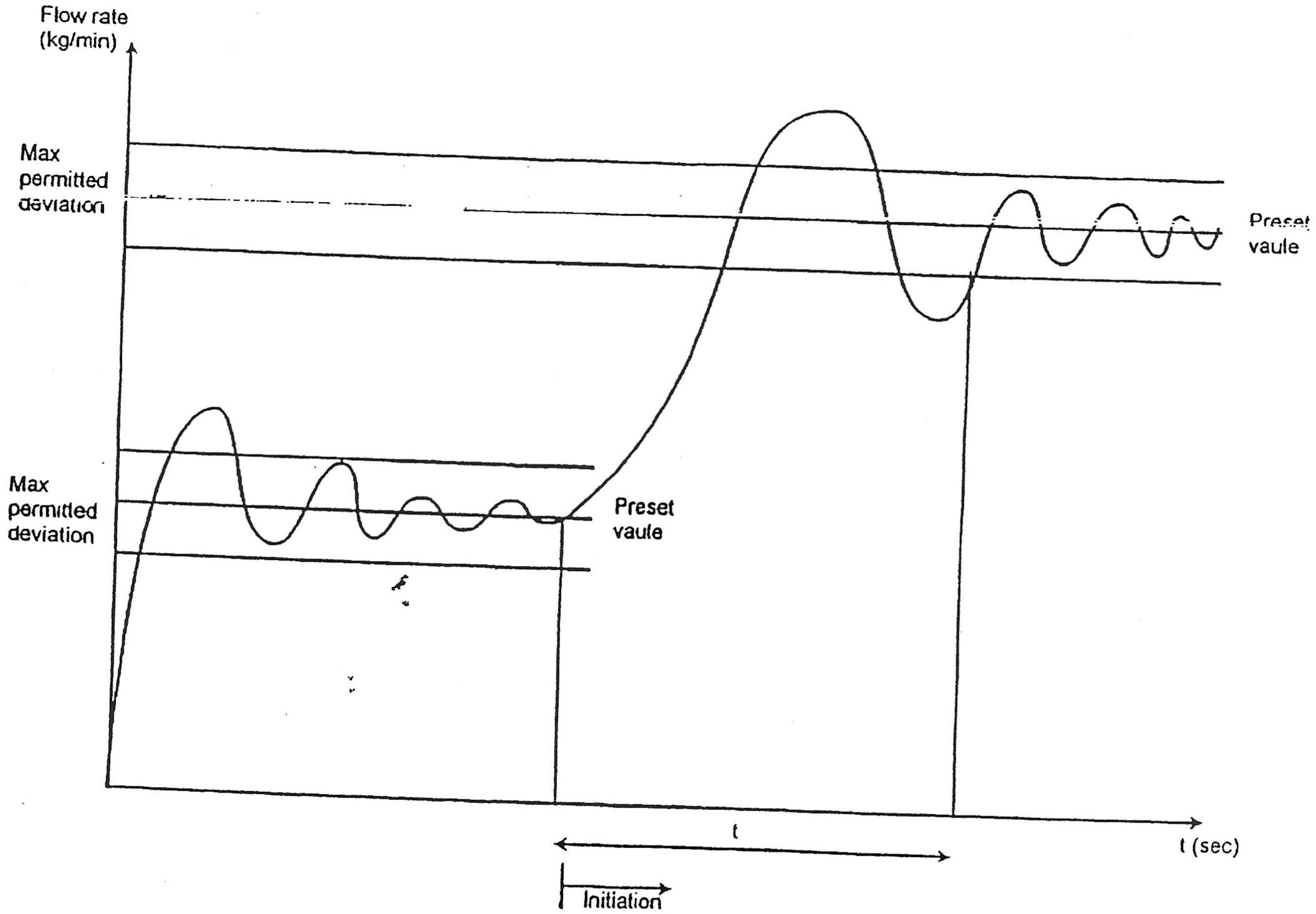


Figure 1. Example of types of regulation

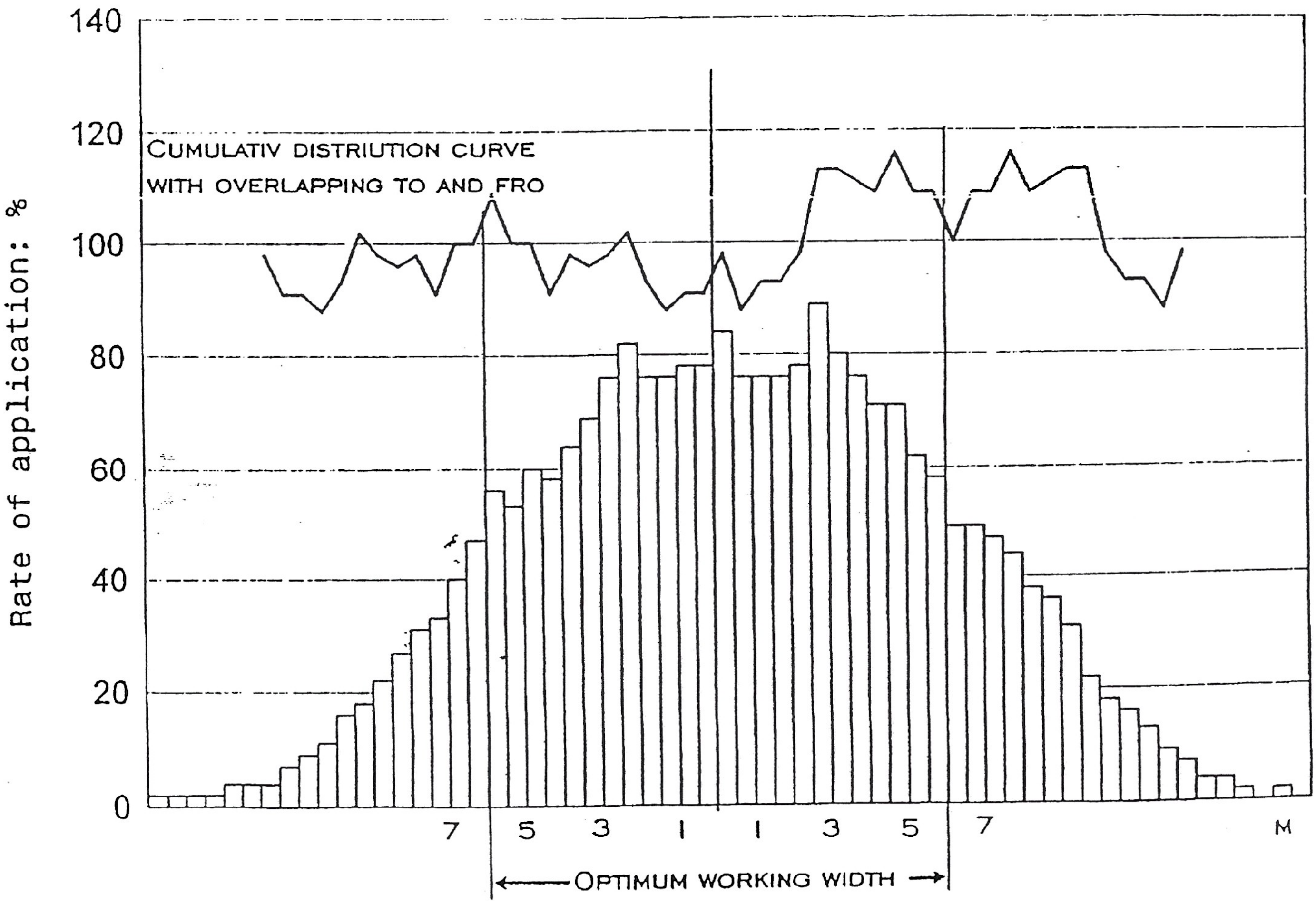
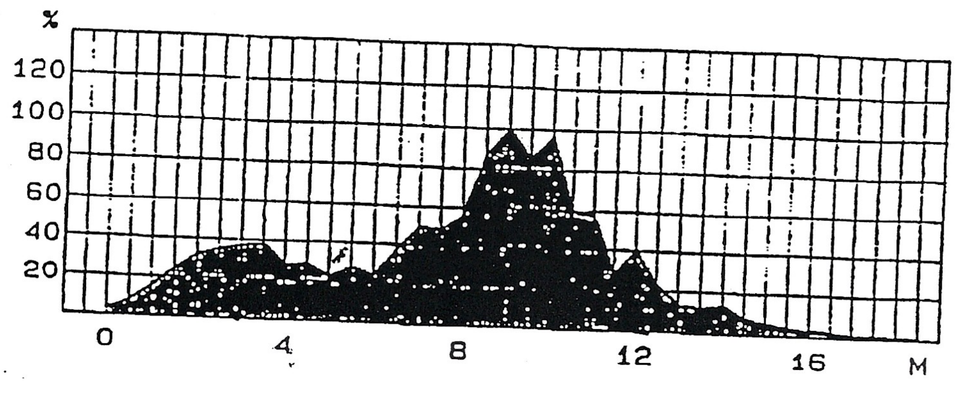


Figure 2. Schematic example showing evenness of transversal distribution



Figur. 4: Schematic example showing rearward trowing length

Annex A (Normative)
Determination and specification of physical properties of test materials

Table A.1 : Physical characteristics for miniral fertilizers

Physical characteristics	Mineral fertilizer types					
	Granuls > 0,9 kg/dm³	≤ 0,9 kg/dm³	Prills > 0,9 kg/dm³	≤ 0,9 kg/dm³	Compactates	Crystalls
Particle size (mm) D 50 min max EN 1235	2,5 - 4,2 1) 8	1,8 - 3,5 1) 8	1,5 - 3,5 1) 8	1,5 - 2,5 1) 8	2,5 - 5,0 1) 10	0,5 - 1,3 – 8
Bulk density (loose) (kg/dm^3) EN 1236	> 0,9	0,7 - 0,9	> 0,9	0,7 - 0,9	> 0,9	> 1,1
Moisture content (%) 3) 4) max	3,5 (1,0 ²⁾)	0,4	1,0 ²⁾	0,4	3,5	0,9
Flowability (kg/min) 3) 5) min	4,5	4,0	5,0	4,5	4,5	7,0
Grain hardness 6)						

1) Max 2 % of the particles are allowed to be less than 1 mm in diameter

2) Fertilizer containing nitrogen (N)

3) A standard with a test method is under developing within CEN/TC 260. After publication of the standard the values will be corrected accordingly.

4) Until an EN standard is available the following method for evaluation of moisture content apply:

dry 25 grams of the fertilizer in an aluminium bowl at 105°C for two hours in a drying cupboard. For urea the drying time shall be 3 hours at 80°C.. The moister content shall be calculated in percentages as
100 x (initial weight - final weight) / initial weight.

5) Until an EN standard is available the following method for evaluation of flowability apply:

Take mean value of three measurements of times needed to let the fertilizer flow out through a hole of 25 mm diameter in the bottom of a cylinder with 2 dm^3 volume and 80 mm inner diameter. Measuring time is 12 seconds.

6) The fertilizer used has to be as hard as the grain structure is not essentally altered during the spreading. An appropriate test method has to be developed.

Annex B (Informative)
Example of a fertilizer - collecting container

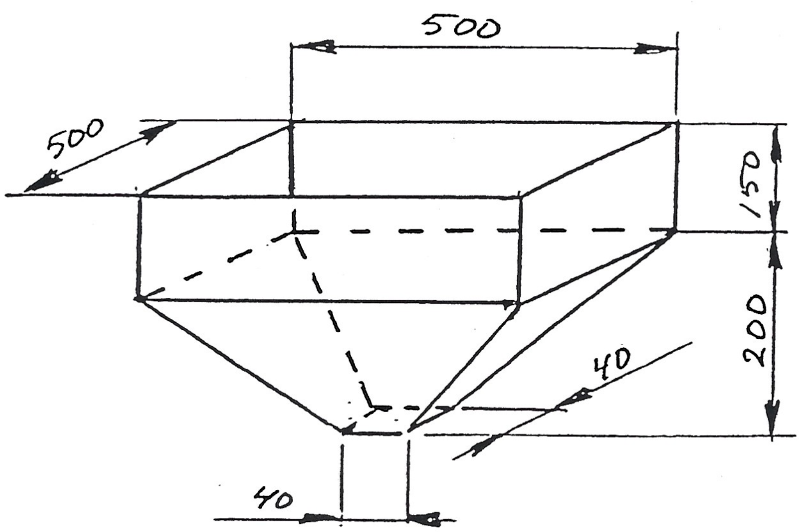


Figure B.1 : Example of a fertilizer - collecting container (funnel) made in stainless steel plate for fertilizer distributor test

Annex C (Informative)
Example of a test report

Name and adress of manufacturer:..

Date and place of testing: ....

Name of responsible test person: ....

C.1 Features of the fertilizer distributor

Make: ....

Type: ....

Model: ....

Identification number: ....

Year of manufacture: ....

C.1.1 Description

Short description of the distributor, for example: mounted, trailed or self propelled; type of feeding system; type of spreading system; working widths and adjustments; equipment for reduced working widths, border spreading; calibration equipment or method; type of automatic control system; other possibilities or limitations.

C.1.2 Dimensions and specifications

C.1.2.1 Common to all types

C.1.2.1.1 All models

Overall length (with control levers located as far as possible so as to project beyond the body of the implement): ....(m)
Overall height of the distributor not hitched to tractor: ....(m)
Overall width: ....(m)
Loading height: ....(m)
Unladen mass: ....(kg)
Hopper capacity (level): ....(m^3)
Other (accurate) dimensions significant in identifying the model tested:..............................
p.t.o. rotational frequency: .... 540 to 1 000 (min^{-1})
Minimum and maximum working speed allowed by manufacturer: ....(km/h)
Maximum flow allowed by manufacturer: ....(dm^3/s)
Minimum flow allowed by manufacturer: ....(dm^3/s)
Number of feed adjustment positions: ....
Equipment for loading:..............................

C.1.2.1.2 Trailed and self propelled machines

Tyre dimensions: ....x..
Radius under load: ....(m)
and corresponding inflation pressure:.. (kPa)
Track set: ....(mm)
Ground clearance: ....(mm)
Distribution of loads at maximum loading
drawbar eye: ....(kg)
rear axle: ....(kg)
front axle: ....(kg)
Method of braking: ....
Stability: ....

C.1.2.1.2.1 Self propelled

Engine make: ....
Engine type: ....
Propelling system: ....
Operators place: ....
Type of steering: ....
Equipment according to traffic regulations: ....

C.1.2.2 Centrifugal distributors

Height of discs or mechanism above the soil or crop as recommended by the manufacturer (machine in operation): ....(mm)
Diameter of discs: ....(mm)
Maximum distance between the outer ends of the wings: ....(mm)
Distance between discs (if there are several of them): ....(mm)
Means of drive: mechanical/hydraulic
Rotational frequency of disc(s) recommended by manufacturer: .... (min^{-1})
Number of positions of the angular distribution control device: ....
Arrangement of blades on the disc: ....

C.1.2.3 Oscillating tube distributors

Height of the centerline of the tube at the fertilizer exit above
the soil or crop as recommended by the manufacturer (machine in operation):
....(mm)
Length of tube: ....(mm)
Diameter of tube at fertilizer exit: ....(mm)
Oscillating angle: ....(°)
Oscillating frequency: ....(min^{-1})
Nature of materials for the tube: ....
Method of drive: mechanical/hydraulic

C.1.2.4 Full-width distributors

Means of transfer of fertilizer: pneumatic/mechanical
Working width:...(m)
Distribution mechanism (short description summary): ....
Number of outlets: ....
and distance between each outlet: ....(mm)

Height of the distributor mechanism, for example spreading plates above ground or crop when working as recommended by the manufacturer: ....(mm)

Type of metering mechanism: ....

Method of drive for the metering mechanism: mechanical /hydraulic.......................................

Maximum flow by mass (for pneumatic distribution devices): ....(kg/s)

C.2 Physical properties of test material

Physical characteristics	Miniral fertilizer types Granuls > 0,9 kg/dm^3	≤ 0,9 kg/dm^3	Prills > 0,9 kg/dm^3	≥ 0,9 kg/dm^3	Compactates	Crystalls
Manufacturer and type	A B C		A B C			A B C
Particle size (mm) D 50 min max						
Bulk density (loose) (kg/dm^3)						
Moister content (%)						
Flowability (kg/min)						
Grain hardness						

C.3 Test conditions

Indoor or outdoor test ?...

Air velocity:...(m/s)

Air temperature: ....(°C)

Indoor humidity: ....(%)

C.4 Test equipment

A description of the test equipment for measuring transversal distribution and flow rates:

....

C.5 Test results

C.5.1 Contact with obstacles

Boom movement: automatic/manual
Test speed: .... (km/h)
Position after test: ....
Damages: Yes/No If yes, which? ....

C.5.2 Filling scale control

Type of method for estimating volume of the hopper: ....
Registered deviations:

		Volume water (dm³)	Hopper scale (dm³)	Deviation (%)
Filling level	10 %			
	45 %			
	80 %			

C.5.3 Adjustment of flow rate

Fertilizer, type and manufacturer: ....
Type of system: ....
Variation range: ....

Test	Set flow rate	Obtained flow rate	Deviation (%)
1	Flow rate + 20 %		
2	Flow rate - 20 %		

C.5.4 Reduced working width

Possibility to reduce working width or change to border spreading with a full hopper? Yes/No

C.5.5 Flow rate regulation system

C.5.5.1 Parameters which influence on the regulation equipment

Influencing parameters: ....
Maximum registered deviations depending on changes in:
Speed: ....(kg/min or %)
Application rate: ....(kg/min or %)
Reduced working widths: ....(kg/min or %)

C.5.5.2 Continuous massflow measurement

Time, from initiation from previous flow rate to the new flow rate (maximum permitted flow rate)..(s)

C.5.6 Evenness of transversal distribution on level ground

C.5.6.1 Statistical results

Coefficient of variation for each fertilizer, flow rate and adjustment.

Make a table over the results for the used fertilizers, flow rates, test speed, working widths and adjustments.

C.5.6.2 Graphic results

Graphs showing correlation between working width and the degree of variation (see figure 2 for model).

Graphs showing correlation between working width and coefficient of variations.

C.5.7 Evenness of transversal distribution near the field edge

Tested border throwing width/-s: ....(m)

C.5.7.1 Statistical results

Maximum registered deviation in application rate within the edge width:..(%)

Coefficient in the transition width (CT):..(%)

Make a table over the results

C.5.7.2 Graphic result

Graphs showing correlation between working width and the degree of variation (see figure 3 for model)

C.5.8 Evenness of transversal distribution when spreading with equipment for top-dressing

C.5.8.1 Statistical results

Coefficient of variation

Make a table over the results

C.5.9 Deviation from intented flow rates

Test at intended flow rate ....(kg/min)
Maximum registered deviation between obtained and intended flow rate:
....(kg/min or %)

C.5.10 Deviation from calibrated flow rate

Maximum registered deviation in flow rate from the calibrated flow rate:
....(kg/min or %)

C.5.11 Evenness of flow rate

C.5.11.1 Flow rate on horisontal ground

Maximum registered deviation in flow rate: ....(kg/min or %)

C.5.11.2 Flow rate on sloping ground

Maximum registered deviation in flow rate:

Inclination upwards: .... (kg/min or %)
downwards: .... (kg/min or %)
to right side: .... (kg/min or %)
to left side: ....(kg/min or %)

Maximum registered deviation from flow rate on horisontal ground:

Inclination upwards: .... (kg/min or %)
downwards: .... (kg/min or %)
to right side: .... (kg/min or %)
to left side: ....(kg/min or %)

Maximum registered deviation between separate feeders: ....(kg/min or %)

C.5.12 Rearward throwing length

C.5.12.1 Graphic results

Graps showing rearward throwing length. See the graph in figure 4.

C.5.12.2 Results

	Maximum amount	No fertilizer	
Distance fertilizer	______________	______________	(m)
	______________	______________	(m)
	______________	______________	(m)

C6 Inspections

C6.1 General

In prEN x-xx-1 some requirements state inspections instead of tests. This part of the test report concerns these inspections.

If there are any remarks, they shall be explained under part 7.

C6.2 Hopper filling opening

Type of design preventing blockages of fertilizer in the flow rate and the speading pattern:..
....

C6.3 Hopper emptying

Possibility to empty the hopper without spreading and without unintentional flow to the ground? Yes/No

If tools are necessary, storage place:..

C6.4 Hopper cleaning

Possible for a person standing on the ground or on the existing access means to clean the machine? Yes/No

C6.5 Calibration aids

Type of calibration aids:..

Relevance of the calibration aids:..

Place of storage on the machine:..

C6.6 Feeding device

Type of marking on the control of the feed mechanism?..................
....

The actuation corresponds to the controls marking? Yes/No

If indicator, visible from driver´s postions? Yes/No

C6.7 Tightness

Is it possible to transport the machine with the feeding device closed without any spillage (with the hopper filled up to the maximum allowed weight)? Yes/No

C6.8 Instruction handbook

Instruction hanbook? Yes/No

Official language:...

Material of the instruction handbook:............................

Durable marks on the machine? Yes/No

<u>Minimum content</u>

-Information for all suitable fertilizers? Yes/No
-Description of the machine´s function and its proper use? Yes/No
-Description of handeling, care and maintenance? Yes/No
-Actions before reading the hopper scale:.................................
-Explanation of risks of corrosion an how to reduce them: Yes/No

COMMON EUROPEAN TEST OF MINERAL FERTILISER DISTRIBUTORS

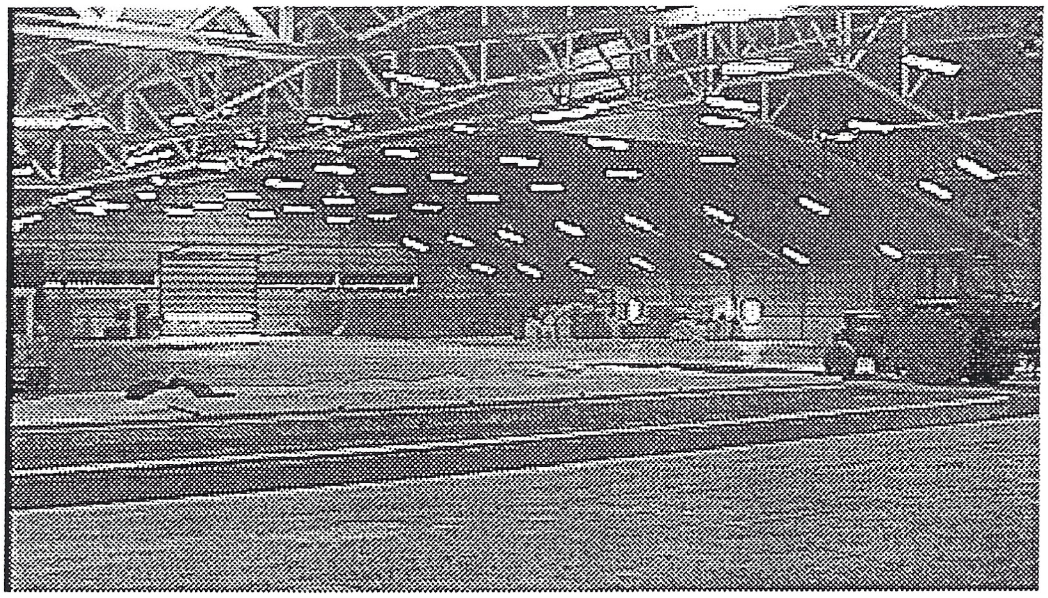
KOPI

TEST PROCEDURE BASED ON CEN/TC 144 / WG3 AH 12
PROPOSALS
N 167-1 REQUIREMENTS
N 167 - 2 TESTS METHODS

The following tests and procedures are proposed by European test stations in Germany, Austria, Switzerland, Netherlands, Belgium, Finland and Denmark
The proposal follows the mentioned CEN draft proposal but changes have been done accordingly to discussions between test stations and the following manufactures: Amazone, Bredal, Bøgballe, Greenland/Vicon, Maschinen- und Antriebstechnik (former Güstrow), Rauch and Sulky.

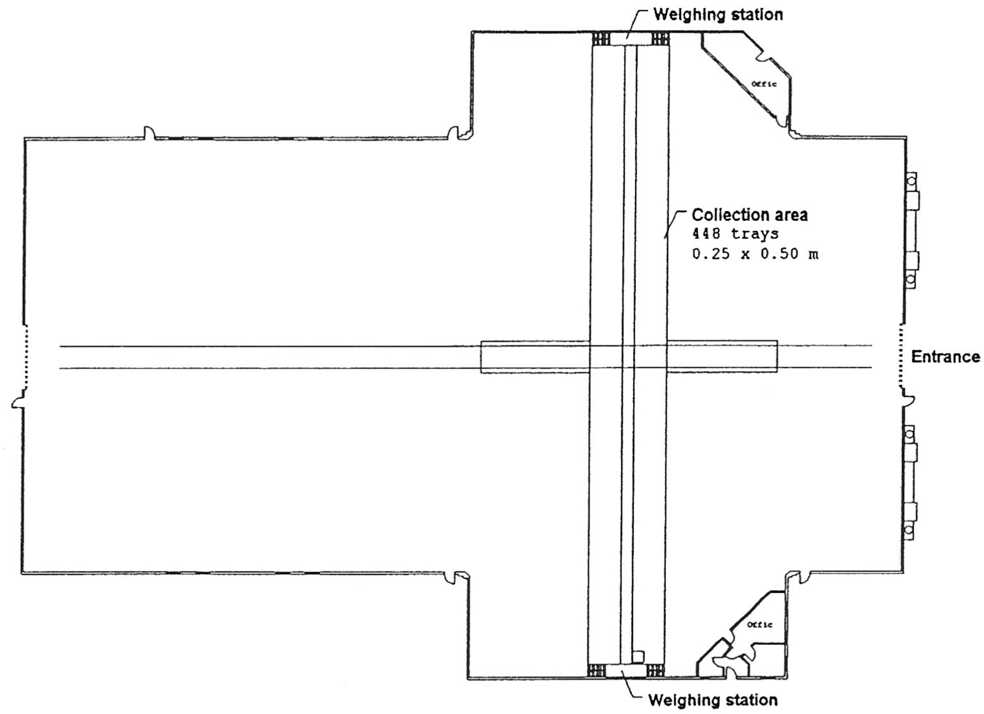
PLACE FOR TESTING

The tests mentioned in the following are to be carried out in Denmark at Research Centre Bygholm



RCB has an 80 x 60 metre test laboratory in which it is possible to carry out full testing of commercial fertiliser spreaders having a throwing width up to 56 meters.
The primary measuring facility is a 56 m wide measuring field, divided into 448 funnelshaped, 0.25 x 0.50 m., 0.80 m deep collecting fields, placed in 2 rows. The spread fertiliser is caught in the fields and collected in small containers under the funnels. The containers are placed on conveyor belts so that they are transported to weighing stations where the quantity of fertiliser in each measuring field automatically is recorded. Data processing takes the form of calculating te the spreading pattern, te coefficient of variation for distribution uniformity and the dosage.
Temperature as well as humidity are controlled by installed equipment that ensures a constant minimum relative humidity (normally 50 %) and a lower minimum temperature of 12 degrees Celsius.

The test hall fulfil requirements of ISO 5690 as well as CEN draft CEN/TC144/wg3 N 167-1 and 2



During tests the fertiliser distributor will be mounted to a BM VOLVO tractor running a speed of 7.6 km/h at 540 RPM. When doing spreading tests 4 runs (spreading) will be done before each weighing procedure.

REDUCED TEST PROCEDURE

(POINTS MENTIONED ARE ACCORDING TO THE CEN DRAFT N167 - 2)
<u>If no remarks are made tests will be done according to draft</u>

4,1 Machine for test

Machines to be tested must be standard machines on which no optimisation have been done. Handbooks / instructions books must be delivered in one of the following a languages : Danish, English or German. Instruction handbooks in other language have to be translated.

The instruction handbook have to fulfil requirements in above mentioned standard or other European standards mentioned in e.g. Machine directive.

Distributors to be tested shall be delivered in Horsens and all necessary accessories must be delivered. Instruction handbooks have to be delivered 2 months before date for beginning of test.

Distributor send for testing will be tested at working widths stated by te manufactures.

4,2 Test materials

Test materials will be selected according to the requirements on physical properties mentioned in CEN draft.

Test materials will be selected from the materials that are generally mentioned in instruction handbooks of machines that are to be tested.

The granular fertiliser (bulk density >0.9 kg/dm^3) will be standard test fertiliser for all static test as well as the fertiliser that all spreaders have to be tested with.

Manufactures are allowed to select between other test materials mentioned in CEN-draft. Minimum 2 additional fertilisers have to be selected if types are mentioned in handbook.

In test reports on specifications of fertilisers will be mentioned. The name of producer will excluded.

4,3 **Applications rates**

Used application rates will be calculated from to nutrient content in used fertilisers. The applicated rates will be calculated from the following figures (based on nutrients):

Nutrient	Min application rate kg/ha	Max application rate kg/ha
N < 20 % N > 20 %	20 30	100 120
P_2O_5 (P)	30	30
K_2O (K)	240	240
MgO (Mg)	30	30
CaO (Ca)	?	?

When testing fertiliser no 1 (granular product, bulk density > 0.9 kg / dm3) 3 application rates (minimum, maximum and mean) will be tested. For all other fertilisers mean application rates will be used.

6,1 **Contact with obstacles** <u>Full width spreaders only</u>

Test according to CEN draft

6,2 **Filling scale control**

Static test

Test will be performed with water

6,3 **Adjustment of flow rate**

Voluntary, additional test

Test according to CEN draft

6,4 **Reduced working width**

Inspection

6,5 **Flow rate regulation system (when available)**

Test according to CEN draft

6,6 **Evenness of transversal distribution**

When doing transversal distribution tests 3 tests can be done. The 3 tests must be done according to the following rules:

1. test. : setting chosen from instruction handbook
From test results it shall be judged if a new test shall be done or not. In case that calculated CV% exceeds 15 new test will always be done.

If 2. second test have to be done the following procedure will be followed:

2. test : from instructions given in handbook a new setting shall be found. It must be possible to find a new setting in a way as if the test were done by a farmer in the field only having simple aids for control of spreading pattern.

From test result of 2. test it shall be decided a 3. test have to be done or not.

If 3. second test have to be done the following procedure will be followed:

3. test : Setting for the 3. test will be chosen from instructions given in handbook. Instructions can be of the kind mentioned under 2. test or by special calibration procedures e.g. fertiliser samples send to manufacturer.

Results

Results of spreading tests will be shown as spreading patterns from 1. test and the best of 2. or 3 test. Also CV curves calculated from the 2 mentioned test will be given. Procedure for calculation of CV % is given in CEN draft

6,7 Evenness of transversal distribution near field edge

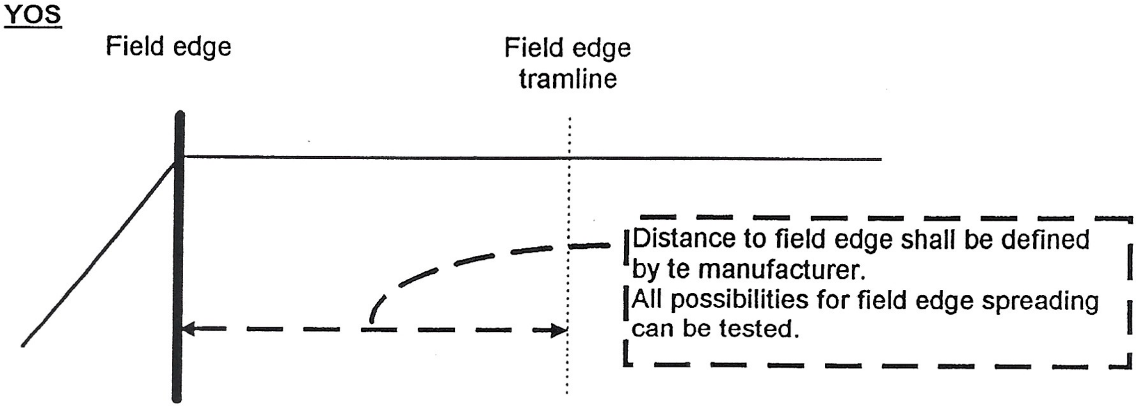
Tests will be carried out at all chosen working widths, for fertiliser no 1 and all other fertilisers chosen by the manufacturer

In the test 4 combinations off doing field edge spreading will be tested according to the choice of the manufacturer.

The 4 combinations of doing field edge spreading will be defined in the following way:

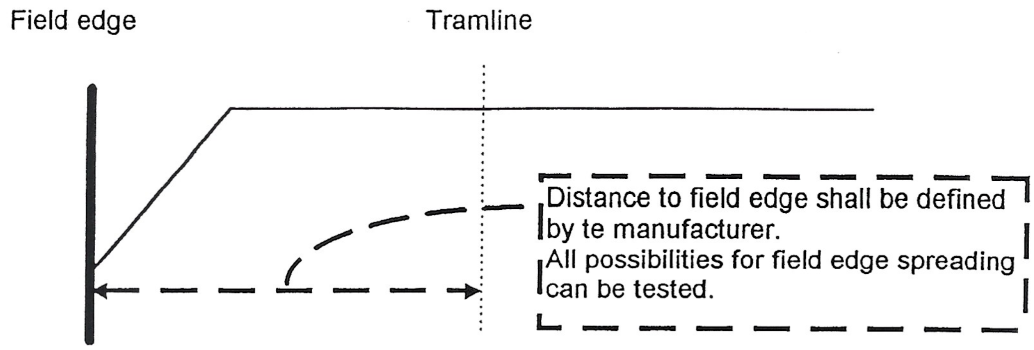
a) *Yield optimisation setting* (YOS) : by this setting the aim is to optimise the fertilisation in a way that fulfil the farmers demand of having 100% fertilising to field edge. Outside field edge the fertiliser distribution should be as little as possible expressed by amount and area of distribution.

<u>YOS</u>



b) *Environment optimisation setting* (EOS) : by this setting the aim is to optimise the fertilisation in a way that fulfil the environmental requirements of having no fertiliser outside the field edge.

EOS

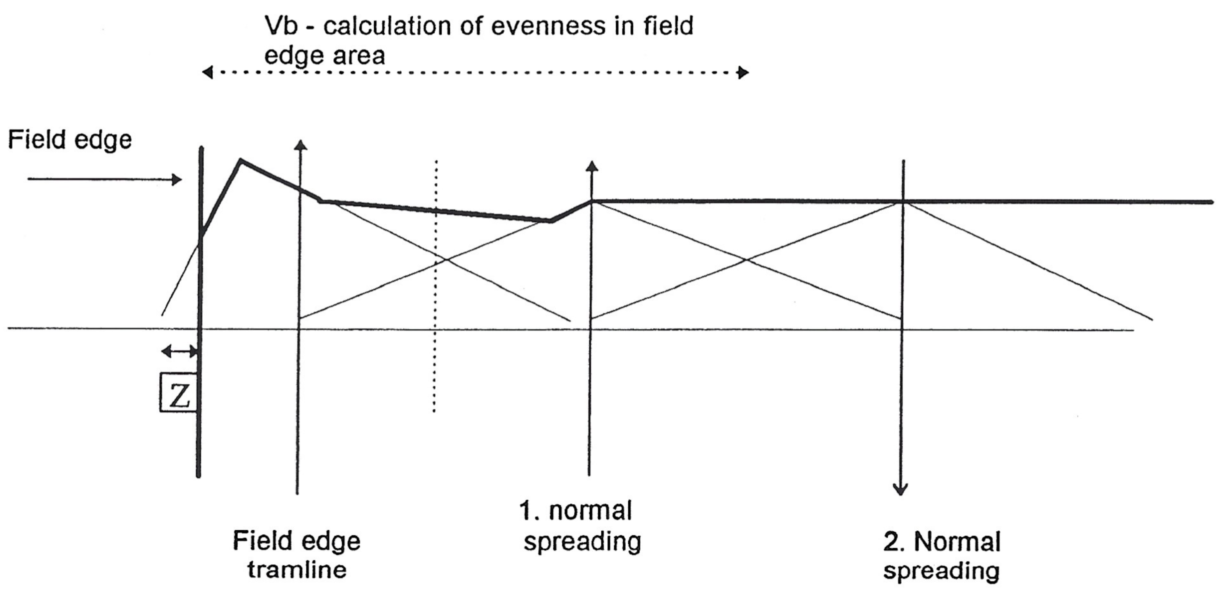


Both types of field edge spreading (YOS and EOS) can be done by travelling in tramlines normally spaced in a distance of ½ working width from field edge (tramline spreading = TS) or by driving in a distance of 2 meters from field edge (field edge spreading = FS).

Settings of all combinations of YOS, EOS, TS and FS shall be stated in handbook.

Test will be carried out in the same way as described in 6,6 except that all instructions have to be found in instruction handbook. By this procedure up till 3 tests per combination is possible.

Results



In this tests the results will be expressed by the following figures :

Z : maximum distance from defined field edge to point in which amounts higher that 2 % of amounts per collector in normal spreading area is found.

V_b : coefficient of field edge spreading.

$V_b = S_b / \bar{x}$ in which

$$S_b = \text{mean deviation} = \sqrt{\frac{1}{(n_b - 1)}} * \sum (x_{ib} - \bar{x})2$$

n_b = number of collectors in field edge area
x_{ib} = amount of fertiliser per collector in field edge area [gr.]
$\bar{x}$ = mean fertiliser amount per collector in normal spreading area [gr.]

Y : lose of fertiliser

Y = G/D in which

G = fertiliser amount outside field edge per metre [gr.]

D = mean fertiliser amount per m^2 in normal spreading area [gr.]

6,8 **Evenness of transversal distribution when spreading with equipment for top-dressing.**

Spreading test performed according to instruction handbook. In case that setting for normal spreading is used for top-dressing the optimised setting found in 6,7 are to be used. No optimisation.

Application rates for all fertilisers will be mean application rate.

Results

Calculated CV% based on 1 test will be given in test report.

6,9 **Deviation from Intended flow rates**

Static test carried out with fertiliser 1 (granular product, bulk density > 0.9 kg / dm3)

6,10 **Deviation from calibrated flow rate**

Static test carried out with fertiliser 1 (granular product, bulk density > 0.9 kg / dm3)

6,11 **Evenness of flow rate on horizontal as well as sloping ground**

Static test carried out with fertiliser 1 (granular product, bulk density > 0.9 kg / dm3)

In addition to the tests mentioned above technical measurements will be done on the distributors. The types of technical measurements are mentioned in the CEN draft annex C.
Examples of measurements of interest to the farmer that will be carried out are:

Possibilities of emptying the spreader.
This test will be carried out by measuring the time for emptying 250 litre of fertiliser from the hopper. The emptying procedure are expected to be described in instruction handbook.

Necessary time consumption for emptying will be registrated as well as the amount of fertiliser that have to be removed manually.

Possibilities of cleaning the spreader
The time for cleaning will be measured and the possibilities of total removal of fertilisers will be judged.

Need of maintenance
The need of maintenance (e.g. lubrication) and time for this procedures will be estimated. Instructions for maintenance should be given in instruction handbook.

Centre of gravity and calculations of lifting force.
Necessary measurements to give farmers information's about possibilities of lifting and running the distributors will be carried out.

Power requirement during spreading
Necessary power (mechanical or hydraulic) requirements for running the spreader when spreading at maximum working width and maximum application rate for spreading fertiliser type 1 will be measured.

No test / inspections according to safety standards, traffic regulations etc. will be carried out at RCB.

Based on the tests carried out at RCB a common test report in English language will be prepared. National reports have to be prepared on basis of this. Costs for translation and printing in each country have to be paid directly to national test station.

Australian Fertiliser Services Association

ACCU-SPREAD CERTIFICATION PROCEDURE

Version 2 - 1999

SECTION 1 - PURPOSE AND SCOPE

1.1 The purpose of this certification scheme is to provide the agricultural industry with an independent and accurate assessment of the evenness of spread of spreading equipment used for spreading dry products.

1.2 The certification scheme aims to differentiate spreaders that have been tested and carry the Accu-Spread logo with those that have not. Spreaders carrying the Accu-Spread logo will be identified as machines that have been tested.

1.3 This procedure applies to centrifugal, pendulum and other broadcast type spreaders used for spreading dry products. It may require some minor modification to accommodate all types of machines and products. These modifications will be in keeping with the principles of this test procedure.

1.4 AFSA is the owner and commissioning body of the Accu-Spread Trade Mark. The official testing authority will be The University of Melbourne or a suitably qualified sub-contractor of their choosing.

1.5 AFSA or persons authorised by AFSA are the persons who are to approve use of the ACCU-SPREAD certification mark.

SECTION 2 - DEFINITIONS

2.1 Dry product will usually refer to dry fertilizer and soil ameliorants. However the procedure could be applied to granular pesticides, dry effluent, soil, salt or other dry granular type products.

2.2 Bout width is the lateral distance between spreader centre lines for overlapping broadcast applications.

2.3 Co-efficient of variation (CV) is a statistical measure of the evenness of spread. The CV is determined by computer simulation using data collected in the tests. The CV is the standard deviation divided by the mean of the deposition. For round and round work patterns it is calculated between successive centre lines and for back and forth work patterns it is determined between the centre lines of the first and third pass.

2.4 Effective bout width is the bout width that will produce acceptable evenness of spread. AFSA has set the standard of acceptable evenness of spread as 15% CV for processed fertilizer products and 25% CV for soil ameliorants and other non-processed products. In effect this means for fertilizer products that the rate varies by less than 15% of the average across 68% of the width.

SECTION 3 - TEST CONDITIONS

3.1 The spreader to be tested should be in good mechanical condition and should be appropriately adjusted for the product and prevailing conditions.

3.2 It is the responsibility of the owner of the spreader to supply AFSA accredited operators for the test.

3.3 The product to be tested is chosen by the owner but it should be representative of the products that are usually used with the spreader.

3.4 An assessment of the granular product may be conducted to determine: bulk density, sieve analysis and product name and manufacturer. This information may accompany the test information. The moisture content of soil ameliorants may also be assessed.

3.5 It is the responsibility of the owner of the spreader to supply product for testing purposes.

3.6 Tests can be conducted in winds of up to 10 km/hr measured 2 metres from the ground. If wind exists, the direction of travel shall be parallel $\pm 15°$ to the direction of the wind.

3.7 The test site will have a slope of less than 2% perpendicular to the direction of travel. The surface should be firm and smooth.

SECTION 4 - TEST PROCEDURE

4.1 Sufficient quantity of product will be loaded into the spreader bins to run the tests and to give "normal" feed onto the distribution mechanism.

4.2 Operators will be given the opportunity to ensure their machines are operating correctly before the commencement of the test. Typically used spreader settings and operating speeds should be used for the tests.

4.3 Two sets of 50 collection trays will be used to capture the product or alternatively two separate runs using one set of 50 trays can be used. Both sets will be laid out in straight lines perpendicular to the direction of travel. The two lines of trays will be at least 20 metres apart. All trays will be spaced at 1 metre intervals, except either side of the centre line where their will be missing trays to allow the wheels of the spreader vehicle to pass over the central tray. The deposit in the missing trays will be estimated by averaging the deposits either side of it. Substitution of the centre trays for another collection device could be done at the discretion of the testing authority. If the results of the two tests give effective bout widths differing by more than 2 metres then the test should be repeated. The testing authority or its representative will select the result that they feel most accurately represents the performance of the spreader.

4.4 The collection trays will be 500 x 500 millimetre square and at least 100 millimetres deep. The total height of the tray should not exceed 150 millimetres. Inside the trays will be anti-bounce inserts that help collect granules. The top of the insert is 25 millimetres below the top of the tray.

4.5 The spreader will pass over the trays a number of times dependent on the chosen application rate, however, at least 600 kg/ha of material should be deposited. For example, this would mean six passes are required at a 100 kg/ha rate or three passes at 200 kg/ha. All passes will be done in the same direction, with the wind.

4.6 The spreader should be running at least 20 metres prior to the first collection trays.

4.7 The contents of the collection trays will be emptied into containers and weighed and the weights recorded. The scales will be certified or verified as suitable for trade use under the relevant state trade measurement legislation. The scale shall be a Class 2 or 3, non-automatic weighing instrument with a verification scale interval of no more than 0.5 grams.

4.8 The recorded weights will be used in a simulation model. The program will determine the co-efficient of variation at various bout widths, using both back and forth and round and round work pattern simulation. The results will be graphed showing the relationship between bout width and CV for both work patterns.

4.9 The effective bout width will be determined from the graph as the maximum bout width with a CV of 15% for processed fertilizers and a CV of 25% for soil ameliorants such as lime and gypsum. Two graphs will be produced for each test, being the results of the two lines of trays. The test will be rejected if the two effective bout widths differ by more than three metres for the one test. If so, the test will be repeated.

4.10 The Accu-Spread certified bout widths will be stated for both work patterns and they will be the average effective bout widths of the two patterns. The effective bout widths will appear on the Accu-Spread certificates.

SECTION 5 - ADMINISTRATION AND LIABILITY

5.1 The Accu-Spread certificates are associated with individual machines using specified products and rates and it will be an offence under the Trade Marks Act if they should be used to imply otherwise.

5.2 The results of the test will expire two years after the date of issue, after which time the certificates must be removed from the spreaders. The spreader should then be submitted for re-testing.

5.3 Accu-Spread trademark can be used in advertising provided that it does not contravene section 5.1 and are approved by AFSA.

5.4 Accu-Spread testing procedure may be subject to change without notice, however, results obtained with out-dated procedures will remain valid until their expiry date.

5.5 Accu-Spread certification can only be obtained through AFSA after successful testing is done by an AFSA approved testing authority.

5.6 Four official Accu-Spread documents will be supplied on successful completion of the test:

a) A sticker that can be applied to the inside window or the spreader vehicle showing the effective bout widths for each product and rate, description of spreader, date of issue and expiry date.

b) A large Accu-Spread sticker to be mounted on the outside of the spreader.

c) An A4 size certificate suitable for framing, giving the same details as the cabin sticker.

d) A laminated A4 size description of the test results, showing distribution patterns and graphs of CV versus bout width for each product tested.

5.7 The results of any test are only valid for the particular machine, product , rate, and settings which were tested.

5.8 AFSA and the testing authority take responsibility for ensuring that the results displayed on the certificate are an accurate representation of the machine that was as tested at that time.

5.9 AFSA and the testing authority take no responsibility for the performance of the spreader after testing.

5.10 Accu-spread stickers can only be applied to the actual test spreader. If stickers are lost, stolen or damaged and a replacement is required then a formal request is required to the National AFSA secretary accompanied with a signed affidavit stating the cause of loss or damage and need for replacement.

5.11 Accu-spread certification will cost AFSA members $500 per spreader, which will include tests on three products of the owners choice. Owners also specify the rate at which the test is performed. Payment of the fee is made in advance of the test to AFSA.

5.12 A certificate may not be issued unless three products are tested, unless suitable reason for having less than three can be supplied to and is accepted by AFSA.

5.13 Tests on more than three products can be arranged at a cost of $100 extra per product for each spreader tested. Further costs may be incurred if modifications are required and tests need to be re-run, these will be done at a time convenient to the testing authority and at a cost of approximately $100 per product or by other mutually acceptable means. These extra costs will be invoiced after the tests are performed and will require payment before the certificates will be issued.

5.14 A schedule will be produced to nominate the location and day of testing. A full day should be allocated to the task of testing a spreader. Generally, the testing day will be organised so that all spreaders are tested with each particular product in turn.

5.15 AFSA and the testing authority take no responsibility for damage to or caused by spreaders, product or operators during the testing period. All spreaders must be operated safely and in accordance with AFSA accredited operator guidelines.

5.16 For the purposes of Workcover and insurance, operators remain employees of the business that owns the spreaders during the test period.

5.17 Operators are responsible for the products they have spread. Therefore, it is the responsibility of all operators that have had tests done on their equipment to clean the site. The spread products need to be collected and disposed of in a manner that will minimise adverse environmental impact. Each testing day will conclude with a general site clean-up, where all are required to assist.

5.18 It is the responsibility AFSA to appoint a local member in charge of testing. That appointee is to locate suitable test sites and to make the owner of the site aware of the nature of the tests that will be performed and the likely impact of this operation on the site. It is necessary that permission to use the site is obtained in writing and is submitted to the testing authority before tests begin.

5.19 Testing will be subject to the prevailing weather conditions and so times and locations are subject to change. Where possible notification of any changes will be made as soon as practicable but it may be very short notice. AFSA and the testing authority will not be held responsible for any cost incurred because of delays. AFSA will not refund amounts paid in advance but will re-schedule testing programs when and where deemed appropriate.

5.20 AFSA will keep a register of all spreader tests. AFSA is at liberty to disclose test results as deemed appropriate with due regard to the possible sensitive commercial nature of the information.

5.21 The testing authority and or their representative has total command over the running of the test procedures. All persons are obliged to cooperate with the testing authority and abide by his or her decisions.

5.22 In the case where operators do not abide by the procedures outlined above the testing authority and the AFSA in charge of testing nominee has the right to withhold Certificates and deny access to testing services.

5.23 Operators can lodge a written complaint to the AFSA's National secretary to appeal against any decisions made.

5.24 The Accu-Spread application form nominating the spreader, products and rates to be tested and accepting the above conditions must be completed and signed before testing proceeds.

5.25 AFSA will appoint three representatives to resolve disputes concerning the use of the Trademark and certification process. If a complaint involves one of the representatives then that representative will stand down and AFSA will appoint a replacement, for the hearing of that particular case. Complaints should be directed in writing to the AFSA secretary, who will forward them to the appropriate representatives. Acknowledgement of receipt of the complaint will be made by the secretary within seven days. Each complaint will be acted upon as deemed appropriate by the representatives within at least two weeks of receiving the complaint. A record of all complaints and the measures made to mediate them will be kept and reported to the AFSA membership at the Annual General Meeting.

ACCU-SPREAD APPLICATION FORM

Where group tests are to be conducted a schedule will be produced to nominate the location and day of testing. A full day should be allocated to the task of testing a spreader. Testing will be subject to the prevailing weather conditions and so times and locations are subject to change. Where possible you will be notified of any changes as soon as practicable but it may be very short notice. AFSA will not refund amounts paid in advance but will re-schedule testing programs when and where deemed appropriate. These conditions do not apply to testing done by arrangement with a sub-contractor.

I wish to nominate, and have attached a cheque payable to AFSA for $500/spreader for the following spreaders to be tested. I acknowledge to have read and understood and I am willing to abide by the rules as explained overleaf and as detailed in the document; Accu-Spread Certification Procedure. I have the authority to make such an agreement with AFSA.

Name: ____________________ Signed: ____________________ Date: / /

Company: ____________________

Address: ____

Telephone: ______________ BH ______________ AH ______________

Mobile: ______________ Fax: ______________

Registration No.	Make and Model of Vehicle	Make and Model of Bin	Make and Model of Spinners	Product 1 and Rate	Product 2 and Rate	Product 3 and Rate

AFSA

Application for Accu-Spread Certification Scheme

Please read the following details regarding the Accu-Spread certification scheme run by AFSA. The form on the back of this page needs to be signed and forwarded to the AFSA National secretary. A full description of the test procedure is attached and further copies can be obtained from AFSA, it is highly recommended that you read this document before you nominate your spreaders for testing. The test procedure is subject to change but results obtained with an out-dated test procedure will remain valid until the expiry date.

You need to nominate the machines, the products and rates you wish to test by completing the form on the back of this sheet and by making the appropriate payment to AFSA. The certificates are associated with individual machines, products and rates and it will be an offence under the Trade Marks Act if they should be used to imply otherwise.

AFSA and the testing authority take responsibility for asserting that the test was performed according to the stated procedure and that the results as stated on the certificate were obtained. However, this does not imply that the operator will always operate equipment as it was tested and so AFSA and the testing authority will not be held responsible for the continued operation of the machine.

The outcome of the tests will be an Accu-Spread certificate, which will be valid for two years, after which time the certificates become null and void. After the test you will be supplied a sticker that can be placed on your vehicle that states the date of test, the expiry date and the bout widths which achieved a 15% co-efficient of variation for processed fertilizer products and at 25% for gypsum and lime. Another large Accu-Spread sticker will be supplied and can be used to advertise the fact your spreader has been tested. It will be an offense under the Trade Marks Act to fix this sticker to spreaders that have not been Accu-spread tested. Two other certificates will be issued one that can be mounted in a frame (for the office) and another A4 size laminated copy showing full test results (for the glove box).

The cost of the test program will be $500 per test, which will include tests on three products of your choosing. You also need to specify the rate at which the test is performed. Payment of the fee is to accompany lodgment of this application form.

Tests on more than three products can be arranged at a cost of $100 extra per product for each spreader tested. Further costs may be incurred if modifications are required and tests need to be re-run, these will be done at a time convenient to the testing authority and at a cost of approximately $100 per product or by other mutually acceptable means. These extra costs will be invoiced after the tests are performed and will require payment before the certificates will be issued.

It is your responsibility to supply an AFSA accredited operator with your machine, AFSA and the testing authority will not be held responsible for poor operator performance or damage occurring during tests or as a result of the tests. The operator will remain as your employee under your supervision. The operator is expected to assist with the testing procedure as directed by the testing authority. It is also your responsibility to supply the products for each test, under normal circumstances these can be arranged with the local organisers at the test site. Site clean up is also your responsibility and should be arranged with the local organisers.

APPENDIX THREE

TABLE 3.1:FACILITIES

Property	Attribute	SPREADMARK (New Zealand)	ASAE (USA)	ES (European Union)	ACU-SPREAD (Australia)
Venue	Indoor/outdoor	Indoor (outdoor by negotiation)	Not specified (depends on specific purpose of test)	Indoor preferred (outdoor by negotiation)	Outdoor
Indoor	Size	< 25 x 45 m	Not specified	80 x 60 m	Not relevant
	Slope	Not specified	< 2%	Horizontal for distribution tests. Static tests done on horizontal, 10^0 upwards, downward, sideways)	Not relevant
	Wind	Not specified	< 8 km/hr (+/- 15^0 in direction of wind)	< 2 m/sec (air temp <25^0C, humidity <65%)	Not relevant
	Surface	Not specified	Hard surface (but depends on purpose of test)	Even, hard surface	Not relevant
	Antibounce	yes	Not specified	Not specified	Not relevant
Outdoor	Slope	Not specified	< 2%, but can be tested on sloping ground for special purposes	Horizontal for distribution tests. Static tests done on horizontal, 10^0 upwards, downward, sideways	< 2%
	Wind	Not specified but recorded	< 8 km/hr (+/- 15^0 in direction of wind)	Recorded	< 10 km/hr @ 2m (+/- 15^0 in direction of wind)
	Surface	Not specified	Similar to field conditions	Recorded	Firm and smooth
	Antibounce	Not specified	Similar to field conditions	Not specified	Not specified

TABLE 3.2:TEST PRODUCTS

Property	Attribute	SPREADMARK (New Zealand)	ASAE (USA)	ES (European Union)	ACU-SPREAD (Australia)
Test products	Number	3 (urea, one with high proportion of fines, one representing 'normal')	1 (either standardized material, or, specific granular material, or, inert simulant)	6 (2 granular, 2 prilled, 1 compacted, 1 crystalline). Static tests on 1 granular product only.	1-3 (operators choice but representative of products normally spread)
Test application rate	Kg/ha	Typical rate for given fertiliser (certified for use at +/- 30% of set application rate)	Typical for product (suggest 25,50,75% of typical rate for multiple passes)	3 rates for each product based on nutrient content	Min of 600 kg/ha (eg 1 pass @ 600 kg/ha or 6 passes of 100 kg/ha
Physical	Particle size	yes	yes	yes	yes
	Moisture content	no	yes	yes	no (except for soil ameliorants)
	Bulk density	no	yes	yes	yes
	Particle density	no	no	no	no
	Granule hardness	no	no	yes	no
	Particle shape	no	yes	no	no
	Surface texture	no	yes	no	no

TABLE 3.3: TEST CONDITIONS

Property	Attribute	SPREADMARK (New Zealand)	ASAE (USA)	ES (European Union)	ACU-SPREAD (Australia)
Speed	Relative speed between distributor and collector	Near field speed	As specified by manufacturer	Normally 8 km/hr (+/- 0.4) (but use 4 km/hr if specified by manufacturer)	Typical operating speeds
Equipment	Condition	Clean, sound, working condition	Good mechanical condition and properly adjusted	Standard machines only (not optimized)	Good mechanical condition
Hooper	load	Hopper outlet covered during test (normally 50 kg)	40-50% of capacity	25% capacity	Sufficient for 'normal' feed
Time	Time or distance before collectors	Not specified	Long enough for flow rate to stabilize (normally 10m). Test within 4 hrs of filling	Not specified	20 m prior to collectors
Passes over collectors	Number	single	Replicated but not averaged (but do allow for multiple passes)	4 at 8 km/hr and 1-2 at 4 km/hr	Depends on set application rate (1 pass at 600kg/ha through to 6 passes at 100 kg/ha)
Height	Distance between top of collectors and distributor	Not specified	Not specified	As specified by manufacturer	Not specified
Amount of fertiliser collected	Weight or volume (+/-)	Gravimetric (+/- 0.03 gm)	Both (accuracy not specified)	Gravimetric (+/- 0.1gm)	Gravimetric (+/- 0.5 gm)

TABLE 3.4: COLLECTORS

Property	Attribute	SPREADMARK (New Zealand)	ASAE (USA)	ES (European Union)	ACU-SPREAD (Australia)
Dimensions	Width (cm)	50	> 30	50	50
	Length (cm)	50	= or > width	50	50
	Depth (cm)	Not specified	Not specified	15	10-15
	Thickness (mm)	Not specified	2.3	1.5	Not specified
Anti-rochocet inserts	Present	Yes	Yes (max 10 x10 cm min 5 x 5 cm)	Yes	Yes (not specified)
Frequency	Number/m	60 per 30 m	10 per swath width	224/56 m (2 rows) (fixed)	50 per bout width
Spacing	Distance (c to c)	Continuous (1.0 m c to c)	Discontinuous (uniform spacing)	Continuous (0.5m c to c)	Continuous (1m c to c)

TABLE 3.5: MEASUREMENTS

Property	Attribute	SPREADMARK (New Zealand)	ASAE (USA)	ES (European Union)	ACU-SPREAD (Australia)
Distribution pattern (transverse)	Swath Width	Largest swath for the minimum acceptable CV	Largest swath for the minimum acceptable CV	Largest swath for the minimum acceptable CV	Largest swath for the minimum acceptable CV (ave. of 2 passes)
	Uniformity of distribution (CV)	15% (for N fertiliser) 25% (others) 15% on nutrient deficient sites	Not defined (attempt to achieve 10% but normally 20%)	15% (to and fro)	15% for processed fertiliser 25% for ameliorants (lime, gypsum etc)
	Boarder Spread	Not required	Not required	Application rate not greater than average +/- 20%	Not required
	Reduced working width	Not required	Not required	yes	Not required
Distribution pattern (longitudinal)	Uniformity of distribution (CV)	Optional (no standard specified)	Not measured	Not measured	Measured (test repeated if 2 BW's differ by > 2m)
	Rear-ward throw	Not required	Not required	Measured	Not required
Flow rate	Flow rate (kg/min)	Not measured	Not measured	Max deviation between set and intended flow rate 15,10, 7.5 % at set flow rates of 25, 25-150 > 150 kg/min[1]	Not measured
	Variation in flow rate	Not measured.	Not measured	Max deviation 10,7.5,5 % at obtained rates of 25,25-150, > 150 kg/min[1]	Not measured
Actual application rate	Kg/ha	Measured from collectors (efficiency > 97%). Certified to operate at +/- 30% of certified rate of application	Measured (preferably measured directly, alternatively from collectors assuming 100% efficiency)	Measured (collector efficiency 90-110%)	Not measured
Hopper volume	Filling Scale	Not specified	Not specified	Measured with water	Not specified

Note 1) the European standard requires that all the static measurements such as flow rates be conducted on only 1 granular product. Flow rates measured on horizontal 10^0 upwards, downwards and sideways.

APPENDIX FOUR

Sieve Box
Operation Manual.

By P.A.Bishop
Chemist BSc.

Introduction:

The sieve box is intended to allow the rapid estimation of the granule size profile of a wide range of fertiliser products and assist in the spreading of fertiliser.

Size Profile and Spreading

The size profile of a fertiliser product is one of the limiting factors in the even application of the product by "Spinning Disk" type spreaders.
This is due to a combination of ballistic factors mainly the aerodynamic drag and the energy of the granule leaving the disk .These factors set the maximum distance a granule may travel from the spreader.
This effect has been observed in numerous spreading trials of a wide range of products and has lead to the establishment of an "Alert" level .

Alert Level.

The "Alert" level defines a level of fineness in a fertiliser product which will result in the reduction in spreading pattern of a optimised spreader. This reduction in spreading pattern may result in burning or banding of pasture especially when Sulphate of Ammonia or Potash are being applied . Product such as Superphosphate which give little visible pasture response are excluded from the "Alert" level .
The "Alert" level products should be spread at between ¾ to ½ of the usual spreading bout width to reduce the effect of banding or burning.

Use of Sieve Box

The most important part of any test on fertiliser is the representative sampling and sub-sampling of the product .

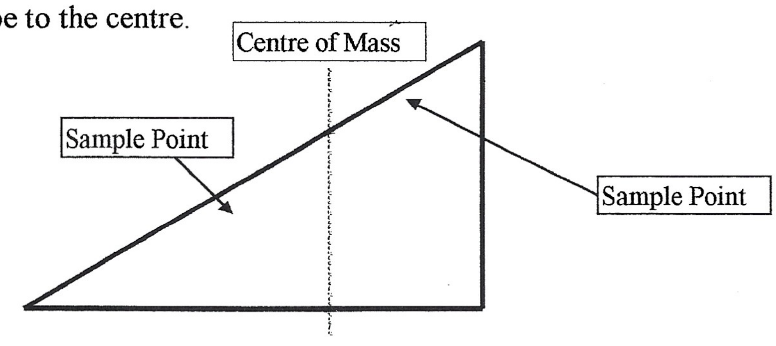
Sampling

General Guidelines

Most fertiliser type products contain a wide range of particle sizes which lead to the segregation of the product on pouring . The segregation means that a higher proportion of large granules will be found in the toe of a pile or in the outer edge of the load on a truck or trailer and finer material will accumulate at the top ridge of a pile or load.
The best way of overcoming this segregation problem is to make a sample up by combining 8-10 samples from a wide range of points. These point samples should be taken from the centre of areas which contain equal volumes .Also if a sample is taken from the toe area a sample should also be taken from the top to compensate for the segregation.

In English this means that the first thing to do when going to sample a pile or truck , is to mentally divide the pile into areas , which you consider to represent equal volumes of product. Then sample from the centre of these areas to a depth of 100mm tacking approximately 200g(1cup).
Then combine the samples. The total sample should be approximately 2-5 kg

Note: the centre of mass(volume) of a triangular cross section is 2/3 of the distance from the toe to the centre.



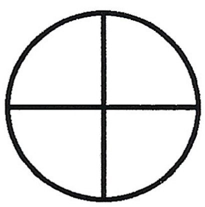
Sub-sampling

The bulk sample should be in the range of 2-5 kg but only approximately 180g[1] required for the sieve box .
To reduce the bulk sample to a suitable size for the sieve box test, without desegregating the sample ,the sample should be Coned and Quartered to about 250g[2]

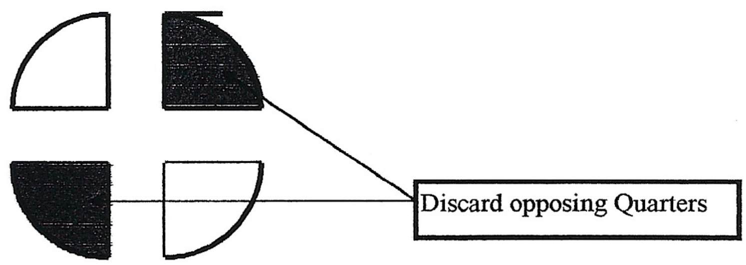
Cone & Quartering

Steps.

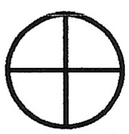
1. First pour the bulk sample onto a clean level surface to form a cone .
2. Then divide the cone into quarters using a shovel.
3. Separate the quarters and discard two of the quarters which are opposite each other .
4. Recombine and mix the remaining quarters to form a cone and repeat this process until approximately 250g[2]mains. On the subsequent repetitions the alternate quarters should be discarded in step 3.



Step 1-2 . Divide cone in Quarters



Step 3. Separate and discard half of sample.



Step 4 . Recombine and mix remaining quarters into cone . Continuing with step 1 to 4 if required

(1) 180g is approximately ¾ of a metric cup.
(2) 250g is approximately 1 metric cup.

Sieve box reading

Hold the sieve Box on a 45^{O} angle and load the sub-sample of the product into the 3.4mm section until full. Then place lid on firmly .
With one hand on the lid and the other hand on the bottom of the box rotate the box on to its side so that the BOP logo is to the top .
Then shake the box with a side to side action approximately 15 times or until the amount of product on each sieve appears constant.
Then return the box to the upright position and gently shake to level product in each of the sieve sections.
Then read the % in each sieve section off the scale on the side of the box or turn to the alert zone to see if the product will cause a problem with spreading.
(The alert zone has been developed on the basis of a "normal" size distribution . In some cases when there has been breakdown off the product or mismatched products have been mixed a double peaked distribution may arise .This situation of a double peaked size distribution may also lead to banding problems and step should be taken to resolve the mix problem, or reduction of the bout width should be recommended.)

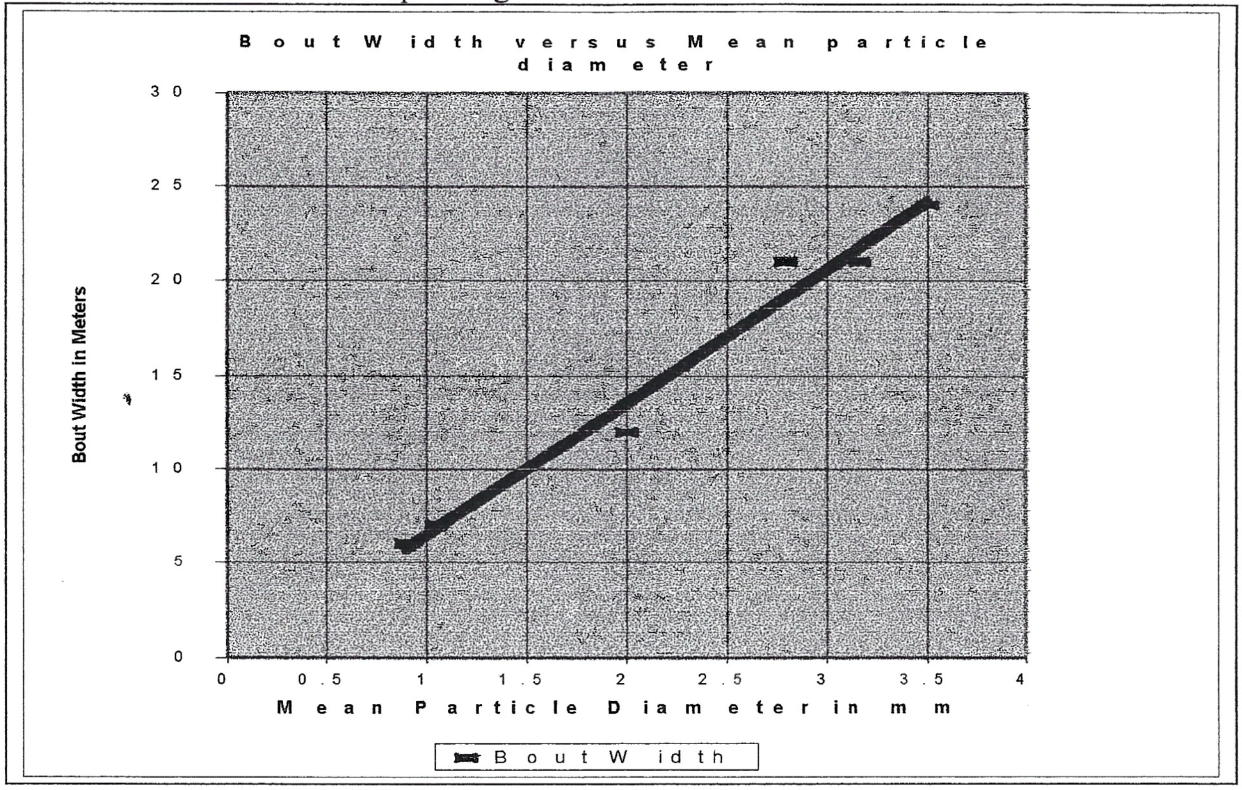
Cleaning

Caution: ***Do Not Wash With Hot Water or Solvent.***

Rinse with cold water and allowed to air dry at room temperature .

The evidence supporting the "Alert" level

After numerous trials a relationship between the mean particle diameter (MPD) and maximum bout width was established. This allowed the setting of a Alert level at a MPD of 1.0mm (50% of the product should be greater than 1.0mm). If the fertiliser has an MPD Lower than this steps should be taken to reduce the bout width to between ¾ to ½ of the usual spreading bout width.



This plot shows the relationship of Maximum Bout Width and MPD for a spreader which has been optimised for normal super with a 15 meter Bout Width.

Summary of Spreading Trials

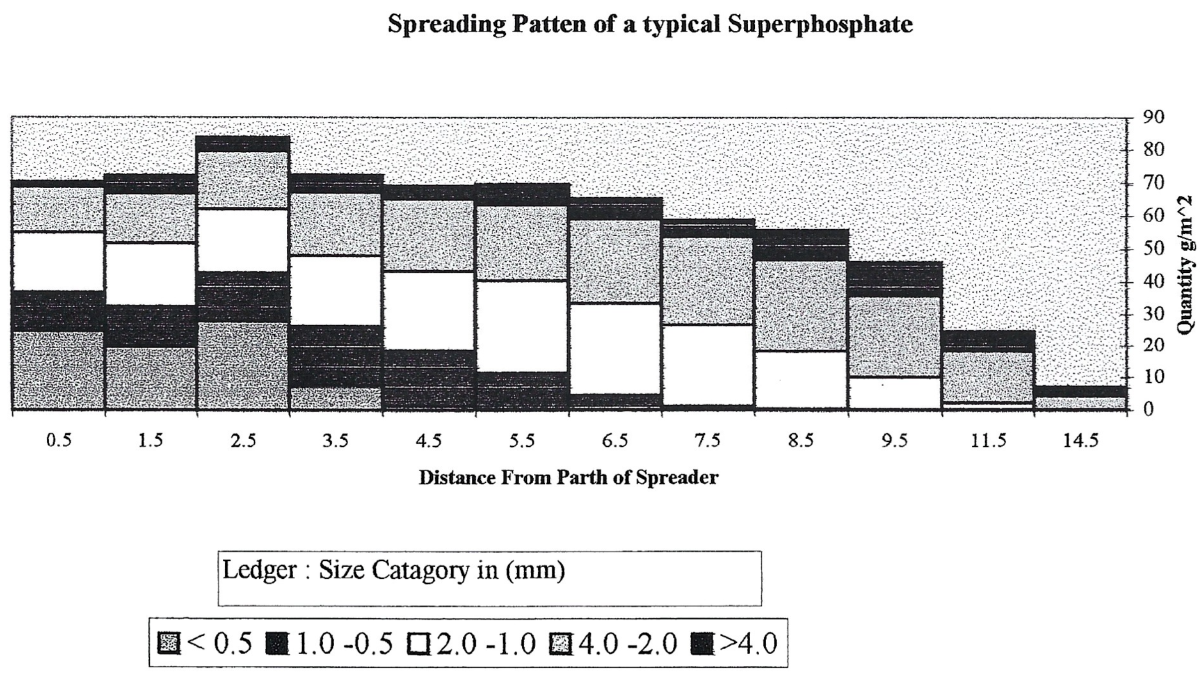
These trials show the effect that the granule size profile has on the spreading pattern of fertiliser.

The main points:

1. Banding occurs when the spreading pattern is extremely uneven.
2. The evenness of the spreading pattern is dependent on the size profile of the product leaving the spinner on an optimised spreader.
3. The process of spreading in most cases worsens the size profile of Fertilisers .

A Typical result from spreading trial.

Sieve Category	> 4.0 mm	2.0 - 4.0mm	1.0 - 2.0mm	1.0 - 0.5 mm	< 0.5mm
%Before Spreading	16	40	26	9	10
% After Spreading	9	34	31	13	12



From these results it can be seen that the Finer portions of the product make the greatest contribution to the quantity of product within the first 3meters from the spreader. Hence if the product contains high levels of fines (< 1.0 mm) banding will occur.