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UPOV

TWC/VII/ 20
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INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

GENEVA

TECHNICAL WORKING PARTY ON AUTOMATION AND COMPUTER PROGRAMS

Seventh Session
Madrid, Spain, May 17 to 19, 1989

REPORT

adopted by the Technical Working Party on Automation and Computer Programs

Opening of the Session

1. The seventh session of the Technical Working Party on Automation and Computer Programs (hereinafter referred to as "the Working Party") was held in Madrid, Spain, from May 17 to 19, 1989. The list of participants is reproduced in Annex I to this report.

2. Mr. C. Prieto Martin, in the absence of Mr. R. Lopez de Haro y Wood, welcomed participants to the National Institute for Seeds and Nursery Plants, Madrid, Spain. The session was opened by Dr. F. Laidig (Federal Republic of Germany), Chairman of the Working Party.

Adoption of the Agenda

3. The Working Party adopted the agenda for its seventh session, reproduced in document TWC/VII/1, after having agreed to discuss items 12 and 15 together, and to discuss item 8 immediately after item 2.

Reports on Subjects of Special Interest to the Working Party Raised During the Twenty-Fourth Session of the Technical Committee and on Questions Raised by Other Technical Working Parties

4. Dr. M.-H. Thiele-Wittig reported on the main subjects of interest to the Working Party raised during the last session of the Technical Committee, referring to the full report on that session reproduced in document TC/XXIV/6 for further information.

Application of the Combined Over-Years (COY) Analysis to Grasses

5. The Working Party noted that, according to the decision taken during its last session, Dr. Weatherup (GB) had amended the program for the calculation of the combined over-years (COY) analysis by including a program for the calculation of significance of joint regression, and a program for the close pair comparison.

6. Mr. Grégoire (FR) introduced document TWC/VII/3 containing a comparison made in France of COY Analysis with the 2 x 1% method. He highlighted the following points: (i) the difference of stringency existing between 2 years and 3 years of tests is in good agreement when using the 2 x 1% or the COY method, if the same level of significance is used in the COY method for both 2 and 3 years of tests; (ii) the difficulty to link the different lambda values for each character to the final over-all characters agreement between the 2 x 1% and the COY methods, and (iii) the fact that optimal significance levels for a smooth transition from the 2 x 1% method to the COY method might change depending on the species, being sometimes 1% and sometimes 5%.

7. Dr. Weatherup (GB) introduced document TWC/VII/8 containing a comparison made in the United Kingdom of the use of COY analysis, modified COY and modified COY applied when regressions are significant. The study on data on the years 1986/1988 resulted in a rather small effect limiting the application of the modified COY analysis to characteristics exhibiting significant regression. A similar study made for the years 1985/87 did not show any reduction in the number of distinct varieties. Under conditions in the United Kingdom, the restriction thus had only a marginal effect.

8. Dr. Laidig (DE) introduced document TWC/VII/16 containing an evaluation made in the Federal Republic of Germany of the COY distinctness criterion. In that study, the COY analysis with 1% significance level was compared with that at 5% and with the 2 x 1% method. In the Federal Republic of Germany, the application of the Modified Joint Regression Analysis (MJRA) resulted in more varieties being declared distinct.

9. Mr. Kristensen (DK) explained the comparison made in Denmark of the different methods of distinctness on the basis of tables distributed during the session and reproduced in Annex II to this document. It was difficult to draw a conclusion from those data. The question arose as to the aim of the test for distinctness.

10. Mr. Baltjes (NL) reported that, according to the experience of The Netherlands, the application of MJRA was not absolutely necessary. The significance level should ensure that differences seen in the field could also be found in the computer data. The risk of declaring a variety not distinct, where it really was, should be reduced.

11. Mr. Grégoire (FR) and Mr. Denis (FR) explained document TWC/VII/10 on the global over-years test for distinctness comparing 5 different proposals for the testing of distinctness, including COY analysis and the 2 x 1% method. They showed in diagrams the different effects of applying one or the other of the five methods to different sets of data with different interactions. On the question what a distinctness test should prove, consistent differences or genetic differences, it was replied that consistent results were required.

12. Mr. Talbot (GB) reported further on his program for the close-pair comparison leading to a grouped COY analysis for the calculation of the residual variance. The program compared varieties closest to the candidate variety. The experts from Denmark, Federal Republic of Germany, France, The Netherlands and the United Kingdom agreed to study or continue to study the program and present their results before March 1, 1990, to the Office of UPOV.

13. Mr. Talbot also introduced document TWC/VII/6 on the estimation of minimum distances from small data sets. It explained the procedure to be followed to calculate a long range LSD from data of the past 3 to 10 years for cases where only a few varieties were in trials and therefore did not permit the application of COY analysis. The Working Party agreed that that method might be very helpful and set up a Group with Mr. Talbot as leader and experts from The Netherlands, Denmark and the United Kingdom to encourage progress before the next session of the Technical Working Party.

14. The Working Party concluded that the calculation of a long range LSD was not restricted to member States with large computer facilities. The computer program was available on diskettes that could run on micro computers, thus every UPOV member State had the possibility of carrying out such analysis.

15. The Working Party finally noted that it had studied the COY analysis for several years. It had agreed that the method provided a better basis for decision taking from the statistical point of view than the former UPOV method and that it led to more consistent decisions over the years. During this study, each member State also had studied the significance level to be foreseen for a smooth transition to COY analysis. Experience of the member States had led to differences with respect to that significance level, which may partly be caused by different environmental conditions and partly by the fact that the present UPOV methods had been interpreted differently in the different countries. The experts in the Working Party stated that as a result of their experience, they would prefer the following significance levels:

		DK	DE	FR	NL	GB
for a smooth	3 years	5	5	5	1	1
transition	2 years	-	5	5	1	0.5
from statistical	3 years	1	5	1	1	1
point of view	2 years	1	5	1	1	1

16. The above levels called for the following remarks. Some experts stated that the use of different standards in different member States should be avoided, since it could lead breeders to make their first application in member States applying the 5% significance level. Other experts expressed their concern that the application of the COY analysis at the 1% significance level would result in a serious reduction of the number of varieties being declared distinct compared to previous criteria applied in those countries. The Working Party was also conscious of the fact that the risk of 2 identical varieties being considered distinct at the 5% significance level was considerably higher than at the 1% level (for figures see Annex III to this document).

17. Having noted the above, the majority of the Working Party recommended to the Technical Committee that distinctness decisions on grasses should be taken with the COY analysis including the Modified Joint Regression Analysis (MJRA) option, using a 1% significance level after 2 years of tests and the same significance level after 3 years of tests.

Application of the COY Analysis to Species Other Than Grasses

Application of the COY Analysis to Vegetable Species

18. Application of the COY Analysis to Leek. Mr. Van der Heijden (NL) introduced document TWC/VII/11 containing a study of the application of the COY analysis to leek, prepared by experts from The Netherlands. The study concludes that the COY analysis at 1% significance level applied to leek is a better method for analysing measured characteristics of leek than the method 2 out of 3. The modified joint regression analysis did not improve the results.

19. Application of the COY Analysis to Onion. Dr. Laidig (DE) introduced document TWC/VII/13 containing a study on the application of the COY analysis to spring onion data, prepared by experts from the Federal Republic of Germany. The study concludes that with the rather small number of candidate varieties available in the test, the COY criterion of 5% gave more distinct varieties than the 2 x 1% method. The results of the COY analysis at the 1% level gave the same result as the method 2 x 1%, but this might have happened accidentally. In general it can be concluded that the number of distinct varieties is not expected to decrease when changing from the present method to the COY analysis at the 5% level.

20. The Working Party agreed on further studies on the application of the COY analysis to vegetable species. Mrs. Campbell will study it on onion shapes by March 1990. All experts will study it on further species and will also use the long range LSD technique and try to apply it to distinctness.

21. Having noted that all data available on vegetable species suggest that the COY analysis is also the best method for the analysis of measured characteristics of vegetable species as long as the number of varieties in the trials is not too low, the Working Party asked that its findings be presented to the Technical Working Party for Vegetables with the proposal that for all vegetable crops the 2 out of 3 method should no longer be applied. The studies of the Working Party on different vegetable species are reproduced in the documents TWC/VI/11 (Onion), TWC/VII/11 (Leek), TWC/VII/13 (Spring Onion) and TWC/VI/13, Annex III (Red Beet). The Working Party asked the Technical Working Party for Vegetables to inform it of any problems it saw with respect to the above proposal and on any further studies the Technical Working Party for Vegetables should consider necessary in this respect.

Application of the COY Analysis to Further Agricultural Species

22. Application of the COY Analysis to Sugar Beet. Mrs. Campbell (GB) introduced document TWC/VII/14, containing a study on the use of COY analysis for sugar beet, prepared by experts from the United Kingdom. The use of the COY analysis at a 5% significance level would give only slightly different

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results compared with the present 2 x 5% method. It was noted that sugar beet was a special case. In the Federal Republic of Germany, The Netherlands and the United Kingdom, different VCU trials were used for DUS testing. However, this would not prevent the use of the COY analysis instead of the 2 x 5% method. It should be ensured, however, that the two methods were not used cumulatively.

23. After having studied the application of the COY analysis to agricultural cross-fertilized species other than grasses, the Working Party found that it offered the same advantages for these species as it did for grasses. The Working Party therefore recommended to the Technical Working Party for Agricultural Crops the introduction of the application of the COY analysis to these species as from 1992. Those member States with enough experience of the COY analysis may apply it to those species forthwith. If the Technical Working Party for Agricultural Crops had no objections to the above recommendation, and if it supported it, the recommendation should be forwarded to the Technical Committee for presentation during its October session.

Testing of Homogeneity in Cross-Fertilized Plants With the Combined Over-Years Uniformity (COU) Criterion

24. Mr. Talbot (GB) recalled the reason behind the program established by him for testing homogeneity using the over-years criterion and the close relation between the COY analysis and the Combined Over-Years Uniformity (COU) criterion. He continued by introducing document TWC/VII/17 on the comparison of actual homogeneity decisions with those of the new method, applied to data of 1988 in the United Kingdom. Dr. Fuchs (DE) introduced document TWC/VII/12, giving the results of the application of that method to data in the Federal Republic of Germany. From the two studies, it was concluded that the comparisons made between the new method for the calculation of homogeneity compared with the present one applied to data of certain grasses gave a fairly good result if the following options were taken:

	DE	GB
- 3 years rejection level at	0.2%	0.1%
- 2 years rejection level at	0.2%	-
- 2 years acceptance level at	5%	1%

25. The Working Party concluded that the COU criterion was a unique method and that all member States should move towards studying that method in applying it to cross-fertilized species. The method was more objective than the present decision practice used in the different member States. The experts from The Netherlands plan to study the method, the experts from France will study the method on luzerne before the next session. The experts from the Federal Republic of Germany will extend their study to maize. Mr. Talbot will receive all these data at the beginning of March for the preparation of a summary.

26. On the question of whether, for small data sets, less than 9 varieties could be used for the calculation of the moving average, it was replied that a reduction to 5 varieties would not lead to serious consequences, a larger number would however assure a smoother relationship between the moving averages.

Testing of Homogeneity in Self-Fertilized Plants

27. The Working Party noted document TWC/VII/4 prepared by experts from the Federal Republic of Germany and indicating some parameters defining a sample scheme, the role of the sample size, and explanations to the tables in its annex prepared for different acceptance probabilities and population standards. Table 11 of that document would be comparable to the table in the General Introduction to Test Guidelines (TG/1/2). The Working Party agreed to present the document to the Technical Committee for approval and thereafter to the individual Technical Working Parties to facilitate their task of choosing the most appropriate levels for each species. The German experts will prepare some further explanations and a recipe for the use of the different tables.

Pair-wise Comparison for Testing Distinctness

28. The Working Party noted that, in the discussions of the Technical Working Parties during the past years, certain misunderstandings had existed among the experts concerning real pair-wise comparison for measured characteristics of varieties grown side by side. There was no specialized procedure for direct pair-wise comparisons. The Working Party repeated, however, that the number of replications in pair-wise comparisons should not be increased as this would change the standard applied.

Review of Statistical Practices

29. This item concentrated on the application of the electrophoresis method. Dr. Fuchs (DE) reported on the last session of the Subgroup on cereals, where they had discussed the inclusion in the Test Guidelines for Cereals of characteristics obtained with the electrophoresis method. The Subgroup took the position that the characteristics should be included in the Test Guidelines. It selected the clearest bands and fixed the proteins. It defined 1 band as 1 characteristic and will indicate reference varieties for the different bands. The states of expression would only be "absent" or "present." It fixed the number of grains and the tolerances (twice the usual tolerance), it agreed that homogeneity in these characteristics would only be required from new varieties, and varieties accepted before introduction would not need to be made homogenous. For the decision on minimum distances, however, more experience would be required.

30. Mr. Grégoire (FR) introduced document TWC/VII/2 on the analysis of electrophoresis data by computer. He highlighted the following points. The coding of the bands should be harmonized and even the chemicals might have to be standardized. A document describing the method and including reprints of reference electrophoregrams should be available from UPOV. New methods not agreed within UPOV should not be used. The use of only one band characteristic to assess distinctness might lead to depreciate Plant Breeders' Rights. A minimum distance approach is possible, integrating the knowledge on hereditary. Databases might be harmonized and the minimum fields to be included agreed upon.

31. Dr. Laidig (DE) introduced document TWC/VII/15 on the computer program to store and analyze electrophoretic data in the Varieties Office of the Federal Republic of Germany. He highlighted the three steps leading to the pattern of bands, the identification and coding of the pattern, the data structure and the program functions. For further work, more knowledge was needed, the bands would have to be identified and a harmonized coding had to be agreed upon.

32. A question arose as to whether the treatment of electrophoretic data should be handled apart or only in the context of the treatment of data in general, whether a small ad hoc system should be established based on present knowledge or an overall solution awaited. It was finally agreed to set up a small Group with Mr. Grégoire (FR) as leader and Mrs. Campbell (GB), Dr. Laidig (DE) and Mr. Van der Heijden (NL), which would prepare for the next session of the Working Party a draft for a data base for electrophoresis data keeping in mind that that draft should not preclude an overall approach.

Description of Varieties

Most Similar Variety

33. Dr. Weatherup (GB) introduced document TWC/VII/9 comparing the t-value method with the Generalized Distance D^2-method. The results indicate that in general both approaches provide the same or nearly the same most similar variety. There are, however, some instances where the methods differ. In that case, the D^2 method will provide a more reliable most similar variety.

34. The Working Party noted that the above method was applicable only to measured characteristics or only with certain reservations to visual observations which can be converted to the continuous 1 to 9 scale. One shortcoming would be that it did not easily allow for weighting different characteristics according to certain criteria as, for example, economic importance.

35. The Working Party agreed to make a survey on existing methods for the identifying of similar varieties. Experts should send their information to Mrs. Campbell (GB) by March 1990.

Standardized Variety Description

36. Mr. Talbot (GB) introduced document TWC/VII/7 outlining the method for obtaining variety scores from continuous measurements. The document explains that there are three possible methods for deriving scores, the first method being the running score which is fixed once a variety has completed a specified number of years of trials, the second being the best estimate method which is based on all of the available data, and the third method involving reading fixed scores for a few varieties and deriving scores for the remaining varieties from the regression of the fixed scores on the variety means over trials. The Working Party encouraged member States to try out the program and to report their findings to the next session of the Working Party.

37. The method was held to facilitate the finding of adequate reference examples for the Test Guidelines. The document on application to pea varieties for that purpose prepared by Mr. Talbot (TWC/VII/19), will be distributed to the members of the Working Party and of the Technical Working Party for Vegetables for information.

Report on the Existing Data Base Management Systems

38. Mrs. Campbell (GB) introduced document TWC/VII/5 on international access to technical administration data. The Working Party discussed the sort of data to which it would be useful to have access and the existing legal constraints which presently prohibit this, as well as the security measures necessary for such access. It agreed that it would be useful to have an

international data base structure which all could adopt or, as those which have already implemented their own structure would not easily change it, at least those countries which build up or plan to change existing data base structures. The data to which access would be helpful, would comprise all data from national gazettes (variety denominations, variety descriptions, etc.) as well as technical data (full test reports, etc.).

39. The Working Party agreed to recommend to the Technical Committee that it discuss the question of access by authorities of other member States responsible for plant variety protection and testing to data held by the Offices of other member States and that it transmit the question to the Administrative and Legal Committee for further study in order to reach coordinated authorization to access the data of other member States. Mrs. Campbell (GB) will prepare by the end of July a paper on that subject for circulation for comments to reach her by September 1, 1989. A revised paper should then be submitted to the Technical Committee for discussion in its October session.

40. Mrs. Campbell (GB) informed the Working Party that there was a project between the United Kingdom and The Netherlands to develop a corporate data structure using ORACLE and SQL. She will keep those so wishing informed on the progress of that project and would welcome any comments and try to take them into account. The proposals for the project will be presented to the Working Party during its next session. The experts from France and the Federal Republic of Germany showed their interest in being periodically informed on that development.

41. For the future, the plan was discussed of developing a distributed data base of information with each member State holding its own information and with a common system of query and retrieval.

Programs Which Can Readily Be Assimilated Into Other Plant Variety Computer Systems

42. The Working Party asked that Mrs. Campbell (GB) be informed of any information necessary to update the list of programs prepared for the sixth session of the Working Party as amended in Annex VIII of document TWC/VI/13.

43. The Working Party noted circular letter U 1366 of October 18, 1988, containing at annex a copy of "Delta Newsletter No. 1" of February 1988 and of an article "A Package of Computer Programs For Handling Taxonomic Data Bases."

Progress Report on Machine Vision Techniques for Variety Identification

44. The Working Party decided to discuss this item together with item 15 of the draft Agenda. It noted especially annexes IV and VII of document TC/XXV/4. It further noted the report from The Netherlands on the new computer and commercial program on image analysis acquired recently. Detailed information supplied by the experts from The Netherlands after the session is reproduced in Annex IV to this document. Mr. Bar Tel (IL) reported that studies on the use of image analysis on carnations had been stopped in his country, as it was considered too expensive compared with its possible application. Changes were difficult to apply by oneself and would thus have to be paid for each time.

Revision of the UPOV Model for a Report on Technical Examination

45. The Working Party noted documents TC/XXIV/4 and TC/XXIV/6, paragraphs 72 to 74, as well as document TC/XXV/6. It could agree in principle to the proposed amendments and decided that it would leave the details to the other Technical Working Parties. It added that it should be ensured that there was no duplication of information and that all information should be able to be stored by computer. It proposed that each item in the forms should be given a number and that the forms and the different revised versions should be numbered as well. Once the revision was completed, it was important that the revised form should be introduced by all member States within a fixed period of time.

Cooperation With Breeders in the Testing of Varieties

46. The Working Party noted documents TC/XXIV/6, paragraph 65, and TC/XXV/5. It agreed that the latter document contained valuable information which should be supplemented by more of the member States.

New Methods, Techniques and Equipment in the Testing of Varieties

47. The Working Party noted documents TC/XXIV/6, paragraphs 38 and 39, and TC/XXV/4. It would require detailed study of the part on electrophoresis before its next session.

States of Expression in Test Guidelines

48. The Working Party noted documents TC/XXIII/5, TC/XXIV/3, paragraphs 99 to 107, and TC/XXIV/6, paragraph 61. Only a few experts had copies available of the documents resulting from previous sessions. Thus a discussion had to be postponed to the next session of the Working Party. In the meantime, experts were invited to discuss the documents at national level and send any comments to the Office of UPOV.

Minimum Distances Between Varieties

49. Mrs. Campbell (GB) introduced document TWC/VII/18 prepared by Mr. Law (GB) and containing a summary of the data supplied as a result of the last session of the Working Party. Much more data had been received than those treated in that document. However, for lack of time, those in an untreated form had not been able to be considered.

50. The Working Party noted that in certain cases the minimum distance applied had been lower than the Least Significant Difference (LSD). This should not happen, it should always be higher. The Working Party considered that the study of the long range LSD from data of past results (see paragraph 13 above) could help in finding a solution to that problem. Several experts expressed their concern at minimum distances lower than the observation unit, e.g. less than 1 cm if measurements are taken in cm, or less than 1 day for ear emergence if observations are made on a daily basis. Other experts considered that there was not always a problem having LSDs smaller than the observation unit because the values to be compared were obtained by the mean of 3 to 6 replicates of 10 to 20 observations. The whole question will have to be studied further. Mr. Talbot (GB) will study the above data supplied by the Technical Working Parties further and will report on further questions contained in those data for the next session of the Working Party.

Questions Raised by Other Technical Working Parties

51. The Working Party noted paragraph 40 of document TC/XXIV/6, referring to certain objections by other Technical Working Parties to excessively fast introduction of new statistical methods in the testing of varieties of plants, and considered that there would have to be close cooperation between statisticians and crop experts within the different Technical Working Parties. It noted that some of the Technical Working Parties already foresaw in their agendas for the coming sessions an item on statistical methods with a statistician who would explain to the crop experts certain statistical methods of special importance for the crops to be handled by the Technical Working Party concerned.

Future Program, Date and Place of Next Session

52. At the invitation of the expert from the United Kingdom, the Working Party agreed to hold its eigth session in Belfast, United Kingdom, from June 6 to 8, 1990. The meeting would start at 8.30 a.m. on June 6 and close at 1 p.m. on June 8, 1990. During its session, the Working Party would either continue or commence discussions on the following items:

(i) Report on subjects of special interest to the Working Party raised during the twenty-fourth session of the Technical Committee and on questions raised by other Technical Working Parties (oral reports).

(ii) Combined over-years (COY) analysis:

(a) Grouped COY analysis
(Experts from Denmark, Federal Republic of Germany, France, The Netherlands and the United Kingdom to send their results by March 1, 1990, to the Office of UPOV)

(b) Long range LSD
(Mr. Talbot and the Subgroup from The Netherlands, Denmark, the United Kingdom to advance the study. All member States to study the program)

(c) COY analysis on onion
(Mrs. Campbell to send her data on onion shapes by March 1990 to the Office of UPOV)

(iii) Testing of homogeneity in cross-fertilized plants:
(All experts to study the COU analysis. The experts from France to send their results on lucerne, the experts from the Federal Republic of Germany their results on maize to Mr. Talbot by March 1, 1990)

(iv) Common data structure for data from electrophoresis or other new methods
(Mr. Grégoire, Mrs. Campbell, Dr. Laidig, and Mr. Van der Heijden to prepare a draft for a data base for electrophoresis data)

(v) Description of varieties:

(a) Survey on existing methods for identifying similar varieties
(All experts to send their information to Mrs. Campbell by March 1, 1990)

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(b) Checking of adequate example varieties
(The paper from Mr. Talbot on peas (TWC/VII/19) to be circulated to the Working Party and the Technical Working Party for Vegetables)

(vi) Access to international data:

(a) Survey on data for which access is desired
(All to study for which data access is desired)

(b) Development of a corporate data structure between The Netherlands and the United Kingdom
(Mrs. Campbell to report on the progress made)

(c) Request to the Technical Committee and the Administrative and Legal Committee
(Mrs. Campbell to prepare a draft for a request for a coordinated authorization by the end of July 1989, comments to be sent to her by September 1, 1989, revised draft for the Technical Committee by the end of September 1989)

(vii) Programs which can readily be assimilated into other plant variety computer systems:
(Updating information to be sent to Mrs. Campbell)

(viii) Cooperation with breeders in the testing of varieties
(Progress report on the pilot project in Denmark)

(ix) States of expression in Test Guidelines
(Everybody to study document TC/XXIII/5)

(x) Minimum distances between varieties
(Mr. Talbot to report on questions from data submitted in 1988 by other Technical Working Parties)

Visits and Demonstrations

53. In the afternoon of May 18, the Working Party visited the testing facilities at the testing station at Aranjuez. In the morning of May 19, the Working Party received a presentation of the data base structure in the register of varieties and the system of computer processing of VCU trials.

54. This report has been adopted by correspondence.

[4 annexes follow]

ANNEX I

LIST OF PARTICIPANTS AT THE TECHNICAL WORKING PARTY ON AUTOMATION AND COMPUTER PROGRAMS MADRID, SPAIN, MAY 17 TO 19, 1989

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[Annex II follows]

ANNEX II

COMPARISON OF DIFFERENT METHODS OF DISTINCTNESS IN DENMARK
1987-1988

Crop	Number of candidates	references	variables
Red clover 2 n	1 (2)	69 (70)	10
- - 4 n	5	36	9
Perennial Ryegrass	1	35	10

The results of the comparisons are:

Crop	Number of ND varieties 2x5%	2x1%	T-SCORE	COY 1%	COY 5%	COY 1% (MJRA)
Red clover 2 n	41	46	44	50	47	45
Red clover 4n	21	27	23	12	2	10
-	24	26	24	21	17	15
-	16	25	19	20	7	8
-	19	23	19	11	2	8
-	10	19	11	5	1	4
Perennial Ryegrass	3	6	4	4	1	4

[Annex III follows]

ANNEX III

TYPE I-ERRORS FOR DIFFERENT TESTS,
NUMBER OF YEARS AND NUMBER OF INDEPENDENT CHARACTERISTICS

Number of Years	Independent Characteristics	COY(5%)	COY(1%)
2	1	0.050	0.010
	2	0.098	0.020
	6	0.265	0.059
	10	0.401	0.096
3	1	0.050	0.010
	2	0.098	0.020
	6	0.265	0.059
	10	0.401	0.096

[Annex IV follows]

ANNEX IV

HARD- AND SOFTWARE FOR IMAGE ANALYSIS RESEARCH IN THE NETHERLANDS

At this moment image analysis is mainly performed on workstations or PC's. These are very powerfull stand-alone computers, equiped with specific hardware for graphics. Wellknown brands and types are:

- Sun 3/160 and Sun 4/110 VME-bus

- Apollo DN3000, extra AT-bus (recently taken over by Hewlett-Packard)

- Hewlett Packard 9000, DIO-bus

- DEC VAX-stations GPX, 3200, 3500 and 8000, Q-bus or BI.

- Iris, VME-bus

- Several systems with VME-bus and almost all equiped with a processor of the Motorola 68000 family (i.e. Contextvision, Datacube)

- Several systems with an IBM AT-bus and an Intel 80286 or 80386 processor (i.e. Imaging Technology, Data Translation, Sun 386-i)

- Apple MacIntosh II, Nu-bus (recent development)

Often workstations are equiped with special image processors and/or floating point processors. The buses used (AT, Q, VME, Nu) are much too slow for data transport between video memory and image processor. Therefore a special, very fast link is often used for this transport.

Software

Most software for image processing is available under the UNIX or MS-DOS operating system, and sometimes also under VMS (DEC-VAX). In a market research of Systems International (december 1987) under 28 deliverers of image processing systems, 14 MS-DOS, 11 UNIX and 5 VMS based systems were available (some deliverers offer more possibilities).

Most software is only suitable for greyvalue images. In spring 1988 rather cheap hardware became available for color frame-grabbers and it is to be expected that software for color images will become available quite soon.

The software packages all have the same basic facilities for image processing, such as:
- convolution;
- histogram equalisation;
- segmentation and labeling of objects (not always);
- measurements of certain characteristics of objects (size, orientation, roundness, perimeter etc.) NB: Be aware if automatic labeling of objects is possible.

Image processing and analysis software is deliverable in four different

configurations:
- subroutine packages (Spider, Itex, DT_Iris);
- programmable but not extentable (TIM, Aquity);
- programmable and extentable (ContextVision, TCL-Image, ImageLab, Image-Pro, Semper);
- packages for specific applications (Ispahan for patron recognition, Erdas for remote sensing)

Only a few packages are programmed using a (more or less) common user interface such as X-Windows, MS-Windows, OS-2 Presentation Manager and Apple. It is to be expected that in future years more and more image analysis systems will use standard user interfaces.

In Holland the following proposal concerning hardware and software for image analysis in agricultural research is made:

Since image analysis is still quite immature in agricultural research it seems sensible not to begin with too advanced systems. Multitasking and virtual memory computersystems are not necessary for most kinds of image analysis. A fast processor, a large random access memory and a large data storage memory (disk) are necessary. For long term data storage a fast connection between the central computer and magnetic memory is advisable. Many operations need a special image processor because of speed limitations. Depending on the most frequently used operations such an image processor can be a simple processor (only for most frequently used convolutions), a signal processor (might be in parallel), a floating point array processor or a specially developed processor. For some operations, such as shading correction and thresholding it is often attractive to perform the operations not on the digital image, but directly on the video signal. These operations are then almost immediately performed, which speed can only be reached on a digital image using very expensive hardware.

It might be usefull to have a computer completely compatible with the central computers (in our situation VAX-computers), because of maintenance, backups, datatransfer etcetera. However, using PC-workstations for image analysis has some advantages:

- cheap;
- broad range: XT, AT, 386 (soon also 486)
- large choice of framegrabbers and -processors;
- ethernet connection with central computer possible;
- migration to UNIX and OS/2 possible;
- large choice of software;
- ergonomically attractive (noise and dimensions).

Some disadvantages are:

- addressable memory of MS-DOS is low;

Image analysis systems can be bought as different pieces or can be ordered ready-made. An advantage of ready-made systems is that certain additionals to the systems such as stage control for microscopes, autofocussing etcetera are immediately deliverable. Also courses and training in using the system are often better arranged than with self-build systems.
Wellknown deliverers of complete systems are:

- Cambridge Instruments
  This company is one of the oldest in imageprocessing. Originally completely focussed on metallurgic applications. Now also very good in the medical and biological field. A very attractive feature of these machines is automated shadingcorrection (in hardware). There are two types:

  Quantimet 970: This is a machine with specific hardware for imageprocessing and -analysis. The machine is controlled by a PDP-11/73. The possibilities and performances are impressive, but the hardware has to be considered very old nowadays (1989). The possibilities to develop new software are limited and tools for that purpose are old. Image format up till 896 x 704 pixels.

  Quantimet 520: This is a smaller but more recent sister of the Quantimet 970. The performances are less but, since a lot of operations are done in hardware, still very fast in comparison with software based systems. The system is controlled by an IBM compatible PC. The machine is not standardly equipped for working with greyvalue images (convolutions etc.) The system is reasonably programmable, however with the limitations of specific hardware. Image format 512 x 512 pixels.

- Kontron

  Kontron is working with image analysis since 1974. Connections to light- and electronmicroscopy are very well taken care off, due to collabaration with Zeiss. It is also possible to integrate densometry and 3-D image reconstruction with the systems.

  Ibas: the large image analysis system of Kontron is hardware oriented. Almost all wellknown image enhancement and analysis techniques are implemented (also texture based segmentation). The system is controlled by an IBM compatible PC. Programming facilities are reasonable, however with the limitations of specific hardware. Image format up to 2048 x 2048 pixels.

  Videoplan and Vidas: These systems are taken together because they only differ in software. Videoplan is almost completely focussed on measurements. Vidas is a combination of image processing and analysis. The hardware is an IBM compatible PC and an extended image memory. The possibilties are close to the Ibas system but it is very slow due to the complete software approach. This makes the system relatively easy to program. Image format up to 1024 x 1024 pixels.

  Imco: This is a very recent development of Kontron, of which the model Imco 1000 is said to be very strong in recognising shapes. This system is likely to be the succesor of Ibas, Videoplan and Vidas. The machines can be controlled by either a VAX, Sun or IBM compatible PC.

- ContextVision

  ContextVision is a swedish company, specialised in texture analysis and segmentation. The machines are based on Unix (Motorola 68xxx family). If wanted, texture analysis and convolutions are available in hardware (socalled GOP and BOP processors). The system is programmable, although with the limitations of dedicated hardware. Large image formats are available.

- Joyce Loebl

  This company started in the early 80's with image analysis equipment. It is famous for its programmable video interface for scanning electron-microscopes. Besides analysis techniques available on most systems, this system also offers measurements on Calcium, Sodium and pH with use of fluorescens techniques.

  Magiscan: This is a dedicated hardware image analysis system. It is comparable with Quantimet 970. Because of the 'old' computerarchitecture rather difficult to program and expensive.

  Mini Magiscan: Although the operation of the system is almost identical to that of Magiscan, its hardware configuration is completely different. It is based on an IBM compatible PC with two special boards for image acquisition and processing. The image processing is performed by a Texas Instruments TMS-320 signalprocessor, which is programmable in Pascal. The programmability is easy compared with dedicated hardware systems but difficult compared with software based systems. Image format 512 x 512 pixels.

  Micro Magiscan: As Mini Magiscan, but image format is 256 x 256 pixels. Only available for dedicated systems.

- TCL-Image based systems.

  TCL-Image is a software product of TNO-TPD in Delft, Holland. It is available on many computers (such as Sun, Apollo, VAX, HP, IBM 80386 PC) and under different operating systems (Unix, VMS, OS/2). Multihouse TSI integrates the software with the computer you like and can deliver a completely working system based on TCL-Image.
  Up till now TCL-Image does not support specific hardware and the performance is completely dependent on the computer used. The techniques for image processing and analysis are delivered by both the Technical University Delft and the University of Amsterdam and are therefore less market-dependent. The programmability of the system is very good because of its open and software oriented character.
  Some disadvantages: connections for stage control, autofocussing and mouse-control are not available. The user interface is very complete but less suitable for occasional users.
  The image format is dependent on the hardware used for image acquisition, and software independent.

The RIVRO has chosen for the TCL-Image system on a Sun 4/110CE because:
- TCL is a very flexible system
- TCL is independent of hardware. A few years ago image analysis had to be done in hardware, since computers were not fast enough. Nowadays not hardware is the problem, but software. It is impossible to develop new software for all new hardware, and therefore it seems sensible to chose a hardware independent system.
- We are in direct contact with the Technical University of Delft, so we have very good support.
- Sun computers have a good price/performance ratio and are very suitable for this purpose.
- We can develop routines completely in software on a very fast but rather expensive computer (Sun). Applications can be made available on relatively cheap IBM compatible PC's (with some dedicated hardware if necessary), which makes the overall system for routine purposes rather cheap.

As said in the beginning, there are a few more systems that are completely based on software and can be ported to all kinds of computers.
K. Preston Jr. gives an overview of 87 image processing languages in the book Computer Structures for Image Processing, 1983, Academic Press, London, ISBN 0 12 223340 9, pp. 195-211 (chapter 13). Of course much has changed since 1983, but at that time only four transportable (hardware independent) packages were available.

This paper is merely meant as information. I have tried to give you some information and considerations to make your choice easier. If you want to have more information, you can write me.

If you would like to have more specific information about TCL-Image (price, possibilities etc), you can write to:

Multihouse TSI
Schakelstraat 16
1014 AW Amsterdam
the Netherlands

Gerie van der Heijden, RIVRO, Wageningen.

PS: This document is largely based on an internal report written by V. Roos for all agricultural institutes in the Netherlands.

[End of Annex IV
and of document]