UPOV

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS
GENEVA

TECHNICAL WORKING PARTY
ON
AUTOMATION AND COMPUTER PROGRAMS

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UPOV QUESTIONNAIRE ON IMAGE ANALYSIS IN PLANT VARIETY TESTING

Document prepared by the Office of the Union with information submitted in reply to Circular U 2908

1.   During the revision of the Revision of the General Introduction to the Examination of Distinctness, Uniformity and Stability and the Development of Harmonized Descriptions of New Varieties of Plants (last version as TC/37/9), it was agreed that this should be supplemented by explanatory documents (called TGP documents). In January 2000, UPOV decided to develop a section on image analysis in the process of the technical examination of plant varieties within the appropriate TGP document. For this purpose, a questionnaire was sent out (Circular U 2908) comprising two parts. The first part, to be completed by crop experts, was related to the use of image analysis. The second part related to specific technical information about the hardware and software used and how the information was filed. The completed questionnaires were collected by the experts from France and the Netherlands.

2.   The Annex of this document summarizes the information received in reply to the above-mentioned questionnaire.

[Annex follows]

ANNEX

UPOV Questionnaire on Image Analysis in Plant Variety Testing

1   Fourteen countries replied to the questionnaire on Image Analysis: Australia, Denmark, Finland, France, Germany, Hungary, Netherlands, New Zealand, Northern Ireland, Poland, Russian Federation, South Africa, Switzerland and United Kingdom. Eight of these, namely Australia, Denmark, Finland, New Zealand, Northern Ireland, Poland, Russian Federation and Switzerland mentioned that they were not using image analysis at that time (February 2000). Nevertheless Australia, Poland and the Russian Federation expressed interest in the possible use of image analysis in the future.

2   The answers from the other six countries, France, Germany, Hungary, Netherlands, South Africa and United Kingdom are summarized below:

QUESTIONS FOR THE CROP EXPERT

1 - UPOV Working Party(ies) in which information was given to other member States:

	TC	**BMT**	**TWA**	**TWC**	**TWF**	**TWO**	**TWV**	**CAJ**
France		X	X			X	X	
Germany						X		
Hungary					X			
Netherlands								
South Africa								
United Kingdom			X	X				

2 - Crops and characters concerned:

FRANCE	
Crop (Testing Station)	**Characteristic**
Peas (GEVES Brion)	leaflets
	stipules
	tendrils
	pods
Impatiens (GEVES Brion)	flowers
French marigold (GEVES Brion)	capitulums
Weigela (GEVES Brion)	flowers
	leaves
Strawberry (GEVES Brion)	leaflets
	flowers
	fruits
Corn salad (GEVES Brion)	leaves
Beans (GEVES Brion)	pods
Pepper (GEVES Cavaillon)	fruits
	leaves
Lavender (GEVES Cavaillon)	floral stem
Artichoke (GEVES Cavaillon)	bracts
	heads
	lobe of leaves
Squash (GEVES Cavaillon)	fruits
Basil (GEVES Cavaillon)	leaves
	floral stem
Maize (BIOGEVES)	enzyme gel
Oil rapeseed, rose, hydrangea, pea, sunflower, poplar, strawberry (BIOGEVES)	molecular marker gel
Roses (GEVES Sophia)	flowers
	petals
	leaves

FRANCE (cont.)	
Crop (Testing Station)	**characteristic**
Oleander (GEVES Sophia)	flowers
	petals
	corolline appendages
	flower buds
	leaves
Some other projects under study.	

GERMANY		
Crop (Nº of varieties)	**Characteristic**	
Pea (60)	Leaves:	length
		with
		distance between bottom and largest with
		area
Pelargonium (100)	Leaves	length
		with
Impatiens (80)	Leaves	length
		with
		length without stem
		length of stem
		area
Willow (60)	Leaves	length without stem
		with
		length
		area
Oilseed rape (730) Mustard (70) Fodder radish (60)	Cotyledons	length
		with
		depth on top of the leave
		area
Oilseed rape (600)	Petals	length
		with
		Distance between bottom and largest with
Red clover (100)	Cotyledons	length
		with
		area
	First leaves	length
		with
		area

NETHERLANDS	
Crop	**Characteristic**
Cucumber	5 features + overall description
Carrot	4 features + overall shape description
Flax	2 features
Onion	3 features + overall shape description
Bean and Pea	5 features of the pod
Ficus	several features to quantify leaf size
	leaf shape
	leaf variegation pattern
Ornamentals	Image database
	Current research focused on the use of spectral imaging flower colour comparison

SOUTH AFRICA	
Crop	**Characteristic**
All crops	Seed shape

UNITED KINGDOM	
Crop	**Characteristic**
Carrots	Roots
Celery	Leaves
Faba bean	Leaves
	Pods
Pea	Pods:
Oilseed	Cotyledons
	Leaves
Chrysanthemum	Leaves
Seeds	Proposals for future
Sugar beet	Investigate , proposals for future
Gel analysis	soon

UNITED KINGDOM	
Crop	**Characteristic**

3 - Purpose(s) of the work:

	France	Germany	Hungary	Netherlands	South Africa	United Kingdom
Description of the variety	X		X	X		X
DUS assessment	X	X	X	X		X
Find varieties to compare to a candidate	X	X (image recording)	X			X
Most similar variety (in variety report)						X
Essential derivation						
Gazette						
Quantitative support of expert in special (difficult) cases	X		X	X		X
Evaluate possibilities of the method for future use	X			X		X
Bio Molecular Techniques (i.e. finding banding patterns in electrophoresis gels)	X			X		X
Other purpose, namely:	CD ROM with descrip - tions and images		Description of shape and colours		Seed identifi - cation	

4 - Status of the data regarding the study made on a given variety (image or files):

	France	Germany	Hungary	Netherlands	South Africa	United Kingdom
Given by breeder as information, or compulsory at application time (classical or digital photo?)	X					
Official and publishable after the study in gazette, bulletin,…	X					
As intermediate data to obtain result(s) during the study before decision	X	X	X			X
To keep as retrievable information for use in other studies	X		X			X

Other status, namely	
France	• Methodology research for detection of GMO and self fertile contaminants in male sterile seed lots
Germany	• Images from ornamental varieties are stored in a database to find similar varieties to the candidates • Images used to measure characteristics by image analysis are stores in original format (TIFF) for backup purposes. Compressed images (JPEG) are stores on CDs and can be used as additional information of he variety.
South Africa	• Data kept in seed bank

5 - Could you give a short indication of the costs and savings involved in applying image analysis.

France	- Including the time for preparation of the organs, the image acquisition take between 2-3 and 15 minutes, depending on species and organs. - GEVES Brion can specify the automatic measurement of organs allow to sae 3 months of seasonal staff a year - BIOGEVES: Time saving (note very much), more practical storage of gels, automation and precision of results
Germany	-------------------
Hungary	Not possible
Netherlands	-----------------------
South Africa	Difficult to give indication of saving costs but it saves a lot of time
United Kingdom	No economic evaluation has so far been done though an investigation is underway to evaluate most the cost effective way of extracting DUS measurements in peas by image analysis.

UPOV Questionnaire on Image Analysis

COUNTRY: FRANCE

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

GEVES Brion – françois.boulineau@geves.fr/jean-michel.retailleau@geves.fr
GEVES Cavaillon – Richard.brand@geves.fr/magalie.delalande@geves.fr
GEVES Le Magneraud – fax no. + 33 5 46 68 31 00
GEVES Sophia – marie-helene.gandelin@geves.fr

Hardware used (brand, type)
    X   To obtain images
GEVES Brion: colour scanner HP ScanJet IIcx(LGL: 36 x 22,5 cm; 400 dpi); deskscan software
GEVES Cavaillon: colour scanner HP ScanJet IIcx(A4; 400 dpi); deskscan software
BIOGEVES: colour numeric camera CANON power shot 600; sequencer Licor OS2 & camera Gene Imag IR; spectrophotometer Bioblock
GEVES Sophia: colour scanner UMAX Mirage D16L (A3; 800 dpi); cameleo software

    X   To keep and process data
GEVES Brion – IPC Pentium 200 (32 Mo); Aldus Photostyler 2.0 & Optimas 5.1
GEVES Cavaillon – DELL Pentium pro 200 (32Mo); Optimas 5.1 & Microsoft software
BIOGEVES: Pentium 200 & 300 (32 Mo); Photo impact, biocapt, RFLP Scan
GEVES Sophia – SUN Ultra 1 Creator (64 Mo); cameleo 2.5 & Visilog 5.0.2

    X   To show images on screen or paper
GEVES Brion – Colour screen 8 bits 17"; B& W HP LaserJet 5SiMx (A3-A4), colour Bubble Jet HP Deskjet 1100 C (A3-A4)
GEVES Cavaillon – Colour screen 8 bits 17"; Colour Bubble Jet HP 2500 Cm
BIOGEVES: Colour screen 8 bits 17"; Colour Bubble jet HP 1120 c; B&W Laser HP 8000; Power Point; Bio 1D+++
GEVES Sophia – SUN colour screen 24 bits 21"; HP Colour LaserJet 5M

Is the software/hardware commercially available?:
    X   Yes, from   *DELL, SUN,HP,THETASCAN, CANON, MICROSOFT, CALDERA GRAPHICS, NOESIS, ADOBE, IMASYS, VILBERT/LOURMAT, SCIENCETEC*
    X   Partially, we added own routines/macros (GEVES Brion & Sophia)
    □   **No, specifically developed**

If it concerns specifically developed software, is it available to others:
    □   **Yes**
    □   **No**
    □   **Under special conditions**

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Colour scanner: automatic recalibration at each power on (complete) and before each scan (control). For voluminous objects use of boxes to suppress parasite lights (GEVES Cavaillon and Sophia). Adjustment of luminosity and contrast for some species and/or organs, the same for each organ and/or species (GEVES Brion and Cavaillon)

Gamma adjustment, the same for all images, to have visually a better colour restitution (GEVES Sophia). Sampling density: GEVES Brion, Cavaillon: <=dpi (automatic determination by deskscan software

GEVES Sophia: 100 dpi

BIOGEVES; autofocus camera, non standardized light; camera CCD monochrome + zoom + filter UV/IR, double-laser sequencer

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

GEVES Brion – since 1966, each year between 1500 and 2000 images (JPG format): 30-50 Mega; keeping on hard disk and CD rom

GEVES Cavaillon – since 1997, about 550 images (110 on basil, 145 on pepper, 157 on lavender, 98 on squashes, 95 on artichoke, 2 on lagerstroemia) for a total of 540 mega (TIFF format, compressed for colour images, uncompressed for B&W images); keeping on hard disk and CD rom.

BIOGEVES: since 1998, between 350 and 400 images of gels by year, each of about 20 ko (format JPG) and CD rom of 650 Mb for storage; since 1999 about 350 B&W images of 5 Mo, in average (TIFF uncompressed format) + Disk Jaz of 1 Go for storage of experiments (including images); since 1999 about 100 B&W images of each 350 Ko (TIFF uncompressed format) – fax no. + 33 5 46 68 31 00

GEVES Sophia – between 1991 and 1995, about 180 x 150 Mega of rose images (VISILOG format, 24 bits, uncompressed); keeping on streamer of 150 Mega; since 1996, about 1,4 Giga of oleander images and 2 Giga of rose; keeping on hard disk and CD rom.

Other remarks:

Other use: identification and retrievable information for management of genetic resources (pepper, artichoke, rose, oleander)

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

COUNTRY: GERMANY

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

Mrs. K. Siebert: kathrin.siebert@bundessortenamt.de , tel: +49 511 9566 751……………

Hardware used (brand, type)
    X   **To obtain images** *3CCD video camera Sony DXC-930P, Scanner: HP Deskscan 6100, digital camera: Canon Powershot Pro 70, Unix-Workstation: HP-UX, Win-NT-PC's, thermosublimation printer: Sony, inkjet printer: Canon Bubble Jet 7100*
    □   **To keep and process data**
    □   **To show images on screen or paper**

Is the software/hardware commercially available?:
    X   **Yes, from** *University of Amsterdam (SCIL-Image for image analysis)*
    from IDS Mönchengladbach (Germany) hardware ;and part of software……….
    X   **Partially, we added own routines/macros** *(application for image recording was developed by ourselves)*
    □   **No, specifically developed**

If it concerns specifically developed software, is it available to others:
    □   **Yes**
    □   **No**
    □   **Under special conditions**
        1. to use the image analysis routines requires SCIL-Image-Software
        2. the image recording application works with special hardware components and stores the data in an 'INFORMIX'-database

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Camera: 3CCD Video Camera Sony DXC-930P
Light: Osram Biolux (6500K)
Scanner: HP Deskscan 6100 (resolution: 100 dpi used for image analysis)

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

Other remarks:
Image recording: Images are stored as video image on external device (2000 images from varieties 39 ornamental crops are stored). In near future the recording system will be updated (the images will be stored as JPEG-Images in the database. The application will run on WinNT-PC

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

Germany (cont.)

Crop/Measured object	Number of measured objects per variety	MB (TIFF)	MB (JPEG)	Images obtained by:
pea leaves	20	30 MB	4 MB	scanner (black and white)
pelargonium leaves	10	130 MB	8 MB	video camera
impatiens leaves	10	100 MB	4 MB	video camera
willow leaves	10	250 MB	10 MB	scanner (color image)
rape, mustard, fodder radish cotyledons	30(3x) 2 location 20 (3x) 2 location 20 (3x) 2 location	6 GB	150 MB	scanner (color image)
rape petals	20 (2x) 2 location	2,4 GB	33 MB	scanner (color image)
red clover cotyledons	30 (3x) 2 location	70 MB	6 MB	scanner (color image)
red clover first leaves	30 (3x) 2 location	70 MB	12 MB	scanner (color image)

COUNTRY: HUNGARY

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

Mrs. E. Kristóf, tel: 36 1 2125, fax: 36 1 2125 800…………………………………

Hardware used (brand, type)
    X   **To obtain images**   *video panasonic S-VHS, Q motion video capture and playback card*
    X   **To keep and process data**   *IBM compatible, CD*
    X   **To show images on screen or paper**   *IBM compatible monitor*

Is the software/hardware commercially available?:
    X   **Yes**, *from IBM……………………………………………………….*
    X   **Partially, we added own routines/macros** *software ULEAD MEDIA STUDIO 25*
    ☐   **No, specifically developed**

If it concerns specifically developed software, is it available to others:
    ☐   **Yes**
    ☐   **No**
    X   *Under special conditions*

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Sampling density nearly the same as recommended in UPOV TG's
Camera: panasonic S-VHS
Background: black (for pepper and onion)

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

pepper: 140 varieties   4,500 number of features
onion: 70 varieties   2,500 number of features.

Other remarks:

Using image analysis as a routine would need special developing: video camera, computer with high capacity, special lighting, conveyer belt room for preparation of the samples, etc. All these developments pay their costs if the technique is widely used – not only for some vegetable species but also for ornamentals, fruits or agricultural crops. Another problem is that special software for each crop and characteristic is not commercially available. Specifically developed software is expensive, they would be profitable in case of a large number of varieties and samples.

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

COUNTRY: THE NETHERLANDS

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

Dr. Gerie vander Heijden, Plant Research International B.V.;
g.w.a.m.vanderheijden@plant.wag-ur.nl

Hardware used (brand, type)
    X   **To obtain images**   *PC's with Scil-Image, JAVA-applications, MATLAB. Several type of cameras including B/W, color, spectral (ImSpector/MulitSpec Agrilmager) and digital. Scanners*
    □   **To keep and process data**
    □   **To show images on screen or paper**

Is the software/hardware commercially available?:
    □   **Yes, from………………………………………………….**
    □   **Partially, we added own routines/macros**
    □   **No, specifically developed**

If it concerns specifically developed software, is it available to others:
    □   **Yes**
    □   **No**
    □   **Under special conditions**

NAK (Roelofarendsveen) is using image analysis for variety testing of vegetables. The main crops it is used for are beans, carrots and onions. The system is commercially available (http://www.spccompany.nl/e_cms.htm) and consists of a conveyer belt system with a PC, a B/W camera, lighting cabinet and specialized software.

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

Other remarks:

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

COUNTRY: UNITED KINGDOM

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

m.talbot@bioss.sari.ac.uk

Hardware used (brand, type)
- **X** **To obtain images** *digital cameras*
- **X** **To keep and process data** *Paintshop Pro, Z-image, Web browsers, Visual basic*
- **X** **To show images on screen or paper** *PC Unix workstations*

Is the software/hardware commercially available?:
- ☐ **Yes, from ……………………..**
- **X** *Partially, we added own routines/macros*
- ☐ **No, specifically developed**

If it concerns specifically developed software, is it available to others:
- **X** *Yes*
- ☐ **No**
- ☐ **Under special conditions**

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Standard photographic studio conditions
Minimum of: 1 sample/plant; 2 plants/plot; 2 plots/variety

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

50 Mb

Other remarks:

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

COUNTRY: UNITED KINGDOM

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

Damian Keefe

Hardware used (brand, type)
- **X** **To obtain images** *Imaging Technology*
- **X** **To keep and process data** *PC*
- **X** **To show images on screen or paper** *PC*

Is the software/hardware commercially available?:
- **X** **Yes, from** ………*No- obsolete* ……………………..
- ☐ **Partially, we added own routines/macros**
- ☐ **No, specifically developed**

If it concerns specifically developed software, is it available to others:
- ☐ **Yes**
- **X** *No*
- ☐ **Under special conditions**

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

1 megabyte per year

Other remarks:

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

COUNTRY: UNITED KINGDOM

TECHNICAL QUESTIONS

Telephone number, fax or e-mail of person to contact in order to have more details:

Mike.Parkinson@niab.com

Hardware used (brand, type)
> **X**   **To obtain images**   *A4 desktop scanner HPScanjet II, colour CCD camera Kodak DC260*
> **X**   **To keep and process data**   *PC (various (IBM compatible), CD Rom*
> **X**   **To show images on screen or paper**   *optical disk (obsolete), PC monitor*

Is the software/hardware commercially available?:
> **X**   **Yes, from**   *Software developed in house using C/C++ and IDL, IDL available from: Research Systems In. (UK), 34, Wellington Business Park, Dukes Ride, Crowthorne, Berkshire, RG45 6LS or local dealer, Windows NT*
> ☐   **Partially, we added own routines/macros**
> ☐   **No, specifically developed**

If it concerns specifically developed software, is it available to others:
> ☐   **Yes**
> **X**   **No**, *not without considerable work*
> ☐   **Under special conditions**

Please summarize the recording conditions (standardization of light, sampling density, camera type, conveyer belt…)

Scanner Reflection or transmission mode. 300 dpi
CCD Hand held, in-built flash calibration target in image

Approximate size of data kept (either Megabytes, or number of varieties, number of features, number of images,…)

Storage: Chrysanthemum project in use. Approx. 10KB/image (binary, 50 dpi) current database 57MB on disk.
Chrysanthemum research Approx. 3GB of images currently in use stored on CD ROM. 6 GB by year end? Similar size archive.

Other remarks:

DVD planned.

NB: If you use image analysis for other work than variety testing (seed testing, checks for purity in maintenance, etc.) and you are willing to give information, please do.

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