CZECH FLAX AND HEMP COLLECTION

MARTIN PAVELEK
AGRITEC, RESEARCH, BREEDING AND SERVICES LTD.
SUMPERK, THE CZECH REPUBLIC
OUTLINE OF THE LECTURE

CZECH FLAX COLLECTION
BASIC INFORMATION
STRUCTURE OF THE CZECH FLAX COLLECTION
DOCUMENTATION SYSTEM
METHODS OF EVALUATION
SEVERAL INFORMATIONS ABOUT HEMP COLLECTION
CONCLUSIONS
CZECH FLAX COLLECTION

BASIC INFORMATION

MANAGED IN AGRITEC LTD COMPANY
FINANCIALLY SUPPORTED BY THE CZECH MINISTRY OF AGRICULTURE
COORDINATED BY THE CENTRAL GENE BANK IN PRAGUE-RUZYNE IN THE FRAMEWORK OF “NATIONAL PROGRAMME ON PLANT GENETIC RESOURCES CONSERVATION AND UTILIZATION”
DESCRIBED BY 25 PASSPORT AND 55 SPECIAL DESCRIPTORS IN THE FRAMEWORK OF THE NATIONAL DOCUMENTATION SYSTEM EVIGEZ
CZECH FLAX COLLECTION
BASIC INFORMATION

2081 genotypes are maintained till the end 2009
CZECH FLAX COLLECTION
STRUCTURE BASED ON ORIGIN

- 50% Landraces
- 26% Breeding material
- 24% Varieties
CZECH FLAX COLLECTION
STRUCTURE BASED ON TYPE OF USE

- Fibre: 53%
- Mixed types: 8%
- Linseed: 39%
Documentation in the Czech Republic

Database manager: Iva Faberořová

Webmaster: Ivan Hon

Last update: 3 May, 2005
Documentation of Plant Genetic Resources - Czech Information System on Plant Genetic Resources (EVIGEZ)

Information system EVIGEZ has been developed since 1984 in the Research Institute of Crop Production, Prague as a special user programme for documentation of plant genetic resources in former Czechoslovakia. Since 1992 it has been used by all institutions dealing with plant genetic resources in the Czech Republic (11 institutions located in 14 places). Presently the programme runs under FoxPro environment. Documentation system EVIGEZ consists of three main data sets:

- Passport data
- Characterization and evaluation data (values in scale 1-9, estimated on the base of national descriptor lists, which are presently available for 27 crops)
- Documentation of seed store in the Gene Bank
CZECH DOCUMENTATION SYSTEM
contributing institutes
2081 accessions are included into the collection now.
2040 accessions (98.03%) are described by passport descriptors.
700 accessions (33.64%) are described by special descriptors.
DNA ANALYSIS
GENERAL SCHEME BEING USED BY FLAX

ISOLATION OF DNA FROM PLANT MATERIAL (LEAVES, SEEDS)
PURIFICATION OF ISOLATED DNA
PCR AMPLIFICATION WITH RAPD PRIMERS
SEPARATION OF AMPLIFICATION PRODUCT BY ELECTROPHORESIS ON 2 % AGAROSIS GEL
PHOTODOCUMENTATION AND ELECTROPHOREOGRAMS EVALUATION BY COMPUTER
DNA ANALYSIS

sampling of plant material

15 plants were sampled from every accession
RAPD and ISSR methods were used
CTAB – DNA isolation, DNA bank
Molecular markers used

- **Nowadays:**
  - RAPD
  - ISSR

- **Future:**
  - microsatellite (SSR) repetition
  - retrotransposons
  - IRAP (Inter-Retrotransposone Amplified Polymorphism)
  - RBIP (Retrotransposone Based Inzertion Polymorphism)
40 RAPD primers (Operon) were tested
Material: 12 chosen flax and linseed genotypes
508 markers were found/104 polymorphic (average $10/2$)

OPD20

OPW08
ISSR markers for flax genotypization

- 12 ISSR primers were tested
- low polymorphism was found

CT 9  AG 9  808 GA
Example of ISSR and RAPD analysis

**Advantages:**
* Simplicity of realization
* not necessary to know sequence
* robustness

**Disadvantages:**
* low level polymorphism
* low information value
* low reproducibility
* problems multiplex PCR
* difficult evaluation

ISSR
12 primers tested

RAPD
40 sets
AFLP analysis of flax genotypes

EcoRI-MseI
**IMAGE ANALYSIS**

- Colour image format
  - *tiff; resolution of 8 bit per channel
  - 512 x 512 spatial resolution
  - 256 grays for each colour

**Software NIS Elements AR 2.30** (Laboratory Imaging LtD. Prague, Czech Republic)

- Conversion of colour image to binary form (object and background)
- Modification by software editor (mathematical morphology) erosion, dilatace etc.
- Measurements of parameters
Image analysis - software LUCIA 4.61

Flower morphology description and evaluation

MaxFeret

Area
Gentiana variety – scan original picture of flower petals
Gentiana variety – binary picture
Image analysis – obtained results

digital photographs of two sets X13 accessions per 350 accessions for each one were made.

Flower morphology at 430 accessions were documented: corolla, flower petals, flower sepals, stamens, anthers.

digital photographs of stem and bolls were made at 700 accessions – above perspective, perspective from the side, section of boll.

Parametres of image analysis for chosen characteristics will be calculated and used for accessions identification – finding of similarity or dissimilarity, duplicates detection.
Photodocumentation of flowers for image analysis

700 genotypes from flax collection were evaluated for image analysis

1-196-12 Selection RA

P 6906

Ottawa C.I. 355
Photodocumentation of stem and generative organs for image analysis

Digital photographs of stem and bolls - above perspective, perspective from the side, section of boll
**350 X13 accessions**

analysis according to the ACCENAME descriptor and image analysis for duplicate identification

<table>
<thead>
<tr>
<th>ACCENUMB</th>
<th>ACCENAME</th>
<th>ORGCTY</th>
<th>USETYPE</th>
</tr>
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<tbody>
<tr>
<td>0170</td>
<td>BUCK 114</td>
<td>ARG</td>
<td>3</td>
</tr>
<tr>
<td>0094</td>
<td>BUCK 114</td>
<td>ARG</td>
<td>3</td>
</tr>
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</table>

![Image of floral and leaf samples for accessions 0170 and 0094]
350 X13 accessions
analysis according to the ACCENAME descriptor and
image analysis for duplicate identification

<table>
<thead>
<tr>
<th>ACCENUMB</th>
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<th>USETYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0027</td>
<td>FLEISCHMANNUV</td>
<td>HUN</td>
<td>3</td>
</tr>
<tr>
<td>0059</td>
<td>FLEISCHMANNUV</td>
<td>HUN</td>
<td>1 ?</td>
</tr>
</tbody>
</table>

Images for accessions 0027 and 0059.
350 X13 accessions
analysis according to the ACCENAME descriptor and image analysis for duplicate identification

<table>
<thead>
<tr>
<th>ACCENUMB</th>
<th>ACCENAME</th>
<th>ORGCTY</th>
<th>USETYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0061</td>
<td>MAROC</td>
<td>MAR</td>
<td>3</td>
</tr>
<tr>
<td>0269</td>
<td>MAROC</td>
<td>MAR</td>
<td>3</td>
</tr>
</tbody>
</table>
350 X13 accessions analysis according to the ACCENAME descriptor and image analysis for duplicate identification.

<table>
<thead>
<tr>
<th>ACCENUMB</th>
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<th>ORGCTY</th>
<th>USETYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0024</td>
<td>LA PREVISION</td>
<td>ARG</td>
<td>3</td>
</tr>
<tr>
<td>0171</td>
<td>LA PREVISION</td>
<td>ARG</td>
<td>3</td>
</tr>
</tbody>
</table>

0024 0171
SEED TYPE identification by using IMAGE ANALYSIS Correlation of NUTRITIVE COMPOUNDS with SIZE, SHAPE and COLOUR CHARACTERISTICS

Smýkalová I. 1, Pavelek M. 2, Bjelková M. 2, Hýbl M. 3, Horáček J. 1, Hampl D. 4, Krulikovská T. 5

1Department of Biotechnology, 2Department of Technical Crops, 3Department of Grain Legumes, Agritec Plant Research, Ltd. Zemědělská 16, Šumperk, Czech Republic; 4National Plant Variety Office, ÚKZÚZ, Hroznová 2, 656 06 Brno, Czech Republic, 5Department of Fermentative Chemistry and Bioengineering, Institut of Chemical Technology Prague, Technická 5, 166 28 Prague, Czech Republic
The aims of the study:

- utilization of DIA in germplasm collections of pea and flax seeds as studied objects ..... testing sets
- evaluation of size and shape (quantitative characteristics) by DIA parameters
- utilization of scanner for acquisition of colour images
- evaluation of colour (qualitative characteristics) by DIA parameters
- statistical analysis of the DIA data
- clustering of varieties based on the DIA results
- correlation analysis of DIA data and compounds
Material and Methods

Plant material
Dry mature seeds of model plants

Flax/linseed - small oval seeds pointed to one end in colour range from yellow to dark brown
Pea – large round shape seeds with colour between yellow and gray green

Analysis of 16 varieties (seeds collection of Agritec Ltd., Šumperk)

<table>
<thead>
<tr>
<th>Flax/linseed</th>
<th>*characterization</th>
<th>Pea</th>
<th>characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amon</td>
<td>LL (2.7%) yellow</td>
<td>Alan</td>
<td>S (53.81%) yellow</td>
</tr>
<tr>
<td>Bonet</td>
<td>HL (50.3%) brown</td>
<td>Bohatýr</td>
<td>S (56.16%) yellow</td>
</tr>
<tr>
<td>Jantar</td>
<td>LL (2.1%) yellow</td>
<td>Herold</td>
<td>S (56.76%) yellow</td>
</tr>
<tr>
<td>Jitka</td>
<td>HL (55.2%) brown</td>
<td>Janus</td>
<td>S (50.15%) yellow</td>
</tr>
<tr>
<td>Lola</td>
<td>HL (4.1%) brown</td>
<td>Romeo</td>
<td>S (53.27%) yellow</td>
</tr>
<tr>
<td>Marylin</td>
<td>HL (57.8%) brown</td>
<td>Smaragd</td>
<td>S (51.75%) green</td>
</tr>
<tr>
<td>Rina</td>
<td>HL (61.4%) brown</td>
<td>Tyrkys</td>
<td>S (54.02%) green</td>
</tr>
<tr>
<td>Omega</td>
<td>HL (54.2%) yellow</td>
<td>Zekon</td>
<td>S (50.62%) green</td>
</tr>
</tbody>
</table>

* Low linolenic genotypes (LL) linseed type
* High linolenic genotypes (HL) flax or linseed
Scheme of work on/with binary image

colour image segmentation by threshold setting +

F11 Programme editor: clean, erosion etc. F5 measure
Evaluation of shape and size of seeds by flatbed scanner Canon 4400F (Canon Inc., USA)

Test of stability: comparison of 2 types of scanner: 4400F and 8800F of Canon

calibration of colour perception; 100dpi; 0-255 (white); 0.08mm/px; Mini ColorChecker (X-Rite Inc., USA) white colour (R=243, G=243, B=242)

3x288 seeds per flax/linseed genotype; 3x237 seeds per pea genotype
Quantitative and qualitative parameters images from scanner Canon type 4400F

**Area** - main criterion of the object size.

**Perimeter** - dimension of total border; calculated from 4 projection in directions 0, 45, 90 and 135° based on Crofton’s equal: \( n \times (Pr_0 + Pr_{45} + Pr_{90} + Pr_{135}) / 4 \)

**EqDiameter** - criterion of size derived from area; mean of circle about area coincident with the area of object: \( \sqrt{4 \times \text{Plocha} / \pi} \)

**MaxFeret, MinFeret** - maximum/minimum from Feret’s diameter, projection length of the object at the angle = \{0°, 10°, 20°, ..., 180°\}

**Elongation** - ratio MaxFeret/MinFeret

**Circularity** - the most useful criterion of size evaluation derived from the space and the perimeter; \( \text{Circularity} = 4 \times \pi \times \text{space} / \text{perimeter}^2 \); 1 = circle and other shapes < 1

**MeanRed, MeanGreen, MeanBlue** - means intensity of colour channels

**MeanSaturation** - mean of colour saturation

**HueTypical** - most widely used (typical) hue of colour derived from maximum in hue histogram
Qualitative evaluation of colour characteristics of seeds by macro-optics

Pentax Cosmicar equipped with digital camera DS-U1 (5 Mpixel)
Nikon (Nikon Instruments, CS-Optoteam, Prague)
Munsell Color table Mini ColorChecker (X-Rite Inc., USA)

Measurements: coordinates L,a,b in CIE-LAB colour space

2.5g sample of flax seeds or cca 50-100 seeds of pea - on the black velour

Colour of flax:  
(1) yellow  
(2) olive green  
(3) light brown  
(4) brown  
(5) black-brown  
(6) dark brown

Colour of pea:  
(1) light yellow  
(2) yellow-pink  
(3) waxing  
(4) yellow-green  
(5) dark-green  
(6) gray-green  
(7) light brown  
(8) brown  
(9) black

Method for evaluation of objects colouring

Colour deviation:  \[ \Delta E_{a,b} \]
\[ \Delta E_{a,b} = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2} \]
Chemical analytical methods
Analysis of fatty acids in flax seeds
by gas chromatography according to technical norm ČSN ISO 5508

Determination of total starch in pea seeds
by NIRS (Near Infra-Red Spectroscopy); calibration of device using commercial kit Megazyme „Total starch“, assay method AOAC 996.11

Statistical analysis of data
Software NIS Elements AR 2.30 (Laboratory Imaging Ltd. Prague, Czech Republic)
- automatic export of data to Excel (Microsoft Office 2007, USA)
ANOVA Statistica ver.8.0 (StatSoft Inc., USA)
– variability of each parameter among genotypes
Evaluating computing system MATLAB R2009a
– correlation analysis (one DIAparametr x content of compounds in seed)
- clustering from all DIA parameters
Differences in a group of evaluated varieties

15 measured parameters

**FLAX/LINSEED:**
AMON - 13 parameters except Perimeter and MaxFeret
JANTAR - Circularity, HueTypical, a
BONET – Elongation
Final dendrogram indicate 2 clusters yellow-seeded (Amon, Jantar) and brown-seeded (Bonet, Jitka, Marylin, Rina, Lola).

**PEA:**
more variable parameter Circularity in comparison to flax;
dendogram of 2 different clusters green-seeded (Tyrkys, Zekon, Smaragd) and yellow-seeded (Herold, Romeo, Bohatýr, Janus, Alan)
Histogram of MeanRed, MeanGreen and MeanBlue generated from the DIA data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>MeanRed</td>
<td>185.21</td>
<td>7.2</td>
<td>165.71</td>
<td>199.06</td>
</tr>
<tr>
<td>MeanGreen</td>
<td>142.96</td>
<td>8.62</td>
<td>120.41</td>
<td>162.36</td>
</tr>
<tr>
<td>MeanBlue</td>
<td>99.15</td>
<td>9.59</td>
<td>74.43</td>
<td>121.23</td>
</tr>
</tbody>
</table>

Sample was separately analyzed for each seed → for each variety means, minimum, maximum, standard deviation and histogram from measured values
**Qualitative evaluation of coloring of seeds**

*Colour calibration sets*

**to selection of standard/references variety**

*to acquire typical „calibration seed“*

Advance: L,a,b and means of 100 seeds of the selected variety

the seeds, which corresponded to the most close means of the 100 seeds (the lowest of ΔEa,b) were selected as colour marker
to calibration colour set

**For flax**: 4 different clusters – yellow, light, medium and dark brown analyzed by DIA⁵.

**For pea**: 2 categories – yellow (brown-yellow, orange and yellow) and green category: light green, olive green, green⁸.

**BUT**: colour of the seeds is more variable character

<table>
<thead>
<tr>
<th>sample</th>
<th>Amon1</th>
<th></th>
<th>Amon2</th>
<th></th>
<th>Amon3</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>a</td>
<td>b</td>
<td>L</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>78.784</td>
<td>5.486</td>
<td>28.16</td>
<td>78.76</td>
<td>5.458</td>
<td>28.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calibration set No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70.793</td>
<td>4.125</td>
<td>26.46</td>
<td>71.41</td>
<td>3.999</td>
</tr>
<tr>
<td>2</td>
<td>64.050</td>
<td>5.331</td>
<td>26.18</td>
<td>64.39</td>
<td>5.249</td>
</tr>
<tr>
<td>3</td>
<td>59.507</td>
<td>13.39</td>
<td>30.09</td>
<td>60.15</td>
<td>13.174</td>
</tr>
<tr>
<td>4</td>
<td>59.749</td>
<td>7.223</td>
<td>18.84</td>
<td>60.34</td>
<td>7.112</td>
</tr>
<tr>
<td>5</td>
<td>54.804</td>
<td>12.27</td>
<td>23.38</td>
<td>55.20</td>
<td>12.15</td>
</tr>
</tbody>
</table>

| Results $\Delta E_{a,b}$ | 14.33 | 47.29 | 7.305 | 13.97 | 47.26 | 7.078 | 14.57 |

<table>
<thead>
<tr>
<th>genotype AMON</th>
<th>yellow</th>
<th>olive green</th>
<th>yellow-brown</th>
<th>gray-brown</th>
<th>brown</th>
<th>black-brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amon2</td>
<td>8.004</td>
<td>14.574</td>
<td>20.256</td>
<td>20.922</td>
<td>24.931</td>
<td>34.659</td>
</tr>
</tbody>
</table>

RESULTS of testing set: genotype AMON .... yellow type of flax
Colour qualities of seeds is important distinctive characteristics for:

- determination of colour level
- create clusters

In a case of coincident colour level of seeds (2 ≥ varieties):
- quantitative evaluation of size and shape of seeds

Significant effect on the value of parameters:
- ??year (age of seeds)
- quality of seeds (diseases, maturity etc.)
- conditions of storing

In the study:
brown genotype Marylin (flax)
calculated \( \Delta E_{a,b} \) for independent 3 years: 2005; 2007; 2008
\( \Delta E_{a,b} = 3,467; 3,656; 3,837 \)

RESULTS: Effect of year on the brown colour of seeds in flax is irrelevant
For future:
!! nevertheless to have conversion coefficient to filtrate the effect !!
Correlation of DIA data with compounds

Flax/linseed: Mean values of colour characteristics MeanRed, MeanGreen, MeanBlue (left) and content of fat and fatty acids oleic, linolic and linolenic (right)

Evaluating computing system MATLAB R2009a – correlation analysis (parametr x compounds in seed)
**Significant correlation between content of fat in seeds and some of DIA parameters**

**FLAX / LINSEED**

<table>
<thead>
<tr>
<th>Parametr</th>
<th>correlation fat parameter</th>
<th>p-value</th>
<th>minimum</th>
<th>maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>0.751</td>
<td>0.052</td>
<td>-0.004</td>
<td>0.9621</td>
</tr>
<tr>
<td>EqDiameter</td>
<td>0.765</td>
<td>0.045</td>
<td>0.029</td>
<td>0.963</td>
</tr>
<tr>
<td>Perimeter</td>
<td>0.381</td>
<td>0.400</td>
<td>-0.522</td>
<td>0.881</td>
</tr>
<tr>
<td>MaxFeret</td>
<td>0.514</td>
<td>0.238</td>
<td>-0.390</td>
<td>0.914</td>
</tr>
<tr>
<td>MinFeret</td>
<td>0.520</td>
<td>0.231</td>
<td>-0.383</td>
<td>0.915</td>
</tr>
<tr>
<td>Circularity</td>
<td>-0.043</td>
<td>0.927</td>
<td>-0.771</td>
<td>0.734</td>
</tr>
<tr>
<td>Elongation</td>
<td>0.3192</td>
<td>0.485</td>
<td>-0.571</td>
<td>0.864</td>
</tr>
<tr>
<td>MeanIntensity</td>
<td>0.862</td>
<td>0.013</td>
<td>0.310</td>
<td>0.979</td>
</tr>
<tr>
<td>MeanRed</td>
<td>0.862</td>
<td>0.013</td>
<td>0.310</td>
<td>0.979</td>
</tr>
<tr>
<td>MeanGreen</td>
<td>0.855</td>
<td>0.014</td>
<td>0.287</td>
<td>0.979</td>
</tr>
<tr>
<td>MeanBlue</td>
<td>0.839</td>
<td>0.018</td>
<td>0.232</td>
<td>0.976</td>
</tr>
<tr>
<td>HueTypical</td>
<td>0.829</td>
<td>0.021</td>
<td>0.203</td>
<td>0.974</td>
</tr>
<tr>
<td>MeanSaturation</td>
<td>0.556</td>
<td>0.195</td>
<td>-0.340</td>
<td>0.923</td>
</tr>
<tr>
<td>MeanBrightness s</td>
<td>0.862</td>
<td>0.013</td>
<td>0.310</td>
<td>0.979</td>
</tr>
<tr>
<td>MeanBrightness L</td>
<td>0.863</td>
<td>0.012</td>
<td>0.313</td>
<td>0.980</td>
</tr>
<tr>
<td>MeanBrightness a</td>
<td>-0.853</td>
<td>0.015</td>
<td>-0.978</td>
<td>-0.280</td>
</tr>
<tr>
<td>MeanBrightness b</td>
<td>0.842</td>
<td>0.018</td>
<td>0.243</td>
<td>0.976</td>
</tr>
<tr>
<td>Fat</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Conclusions

- to objective and just and comprehensive description of genotype
- to explore results of both, quantitative (Area, EqDiameter etc.) and qualitative (L,a,b) DIA of seeds
- statistical analysis of DIA data provided by computing programme (MATLAB R2009a etc.)
- function and automatized evaluating technology
- utilization in descriptions and originality in germplasm collections
- quick searching accessions in databases of collection
Hemp varieties trials in 2010
16 foreign varieties included

1. Bialobrzeskie (POL)
2. JUSO – 31 (UKR)
3. Ferimon (FRA)
4. Monoica (HUN)
5. Fibrol (HUN)
6. Futura 75 (FRA)
7. Fedora 19 (FRA)
8. Felina (FRA)

9. Santhica 27 (FRA)
10. Beniko (POL)
11. Epsilon 68 (FRA)
12. KF-TC (HUN)
13. Chamaeleon (FRA)
14. Tygra (POL)
15. Finola (FIN)
16. Uniko B (HUN)
Hemp varieties maintained in genebank in AGRITEC Ltd. Šumperk

- 19 varieties are included

- Slovakia – 2:
  - RASTISLAVICKÉ, KRAJOVÉ Z ČERVENIKA

- Hungary – 2:
  - FIBROL, MONOICA

- Poland – 3:
  - BENIKO, SILESIA, BIALOBRZEZSKIE

- Ukraine – 3:
  - JUSO 11, JUSO 32, JUSO 34

- Romaina – 1:
  - LOVRIN 110

- France – 7:
  - FEDORA 17, FUTURA 75, FELINA 32, FERIMON 12, EPSILON, SANTHICA 27, CHAMAELEON

- Finland – 1:
  - FINOLA
CONCLUSIONS

2081 ACCESSIONS ARE MAINTAINED IN THE CZECH FLAX COLLECTION AT THE END 2009 COVERING AS MUCH GENETIC DIVERSITY OF *LINUM USITATISSIMUM* L. AS POSSIBLE

NEW PROGRESSIVE METHODS OF FLAX GENETIC RESOURCES ARE BEING DEVELOPED BASED ON DNA METHODS RAPD AND ISSR

WE ARE GOING TO VERIFY THE UTILIZATION OF THE LAST MODERN METHODS LIKE MICROSATELITTE (SSR) REPETITION, RETROTRANSPOSONE, IRAP AND RBIP (Inter-Retrotransposone Amplified Polymorphism, Retrotransposone Based Inzertion Polymorphism)
CONCLUSIONS – TO BE CONTINUED

IMAGE ANALYSIS LIKE THE NEW LAST METHOD OF FLAX GENETIC RESOURCES EVALUATION HAS BEEN USED FOR DISTINCTION OF ACCESSIONS AND DUPLICATE SEARCH SINCE 2005
Thank you for your attention 😊