



Genotypic, Phenotypic and FTIR-based Metabolic Fingerprint Diversity in Oat Landraces in Relation to the Environment at the Place of Origin

*Passion for
Biodiversity*

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Landraces



dynamic,
heterogeneous

population



natural
selection
mutations,
migrations,
genetic drift,

evolution



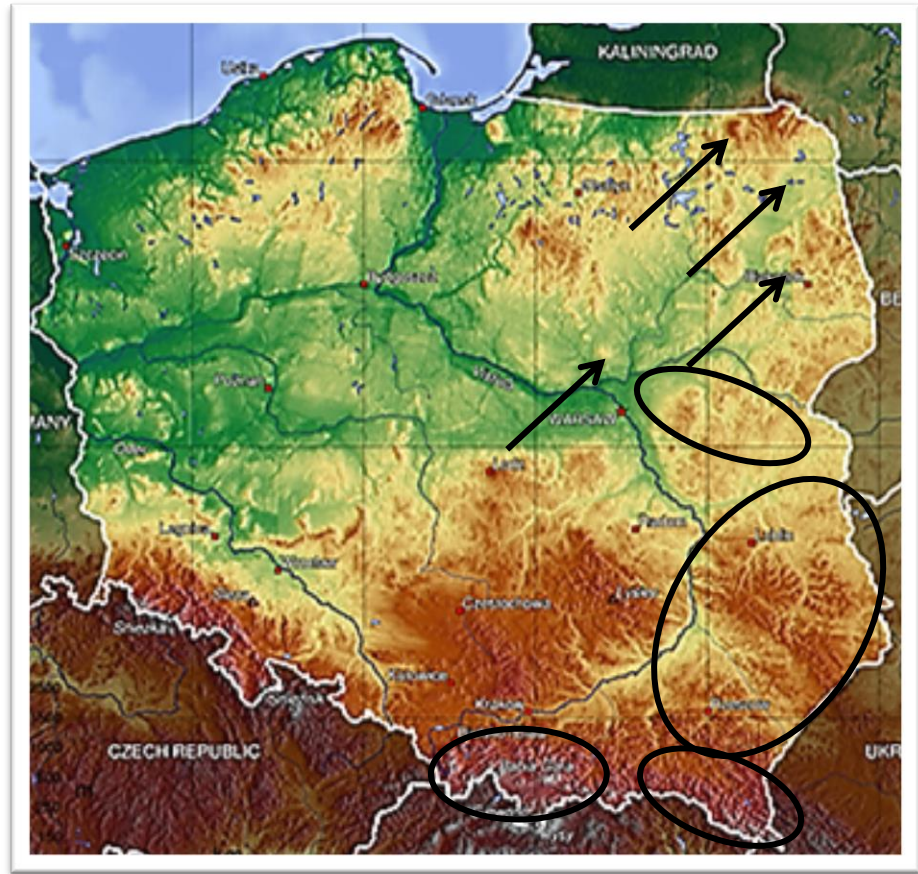
preferences
agricultural
practices

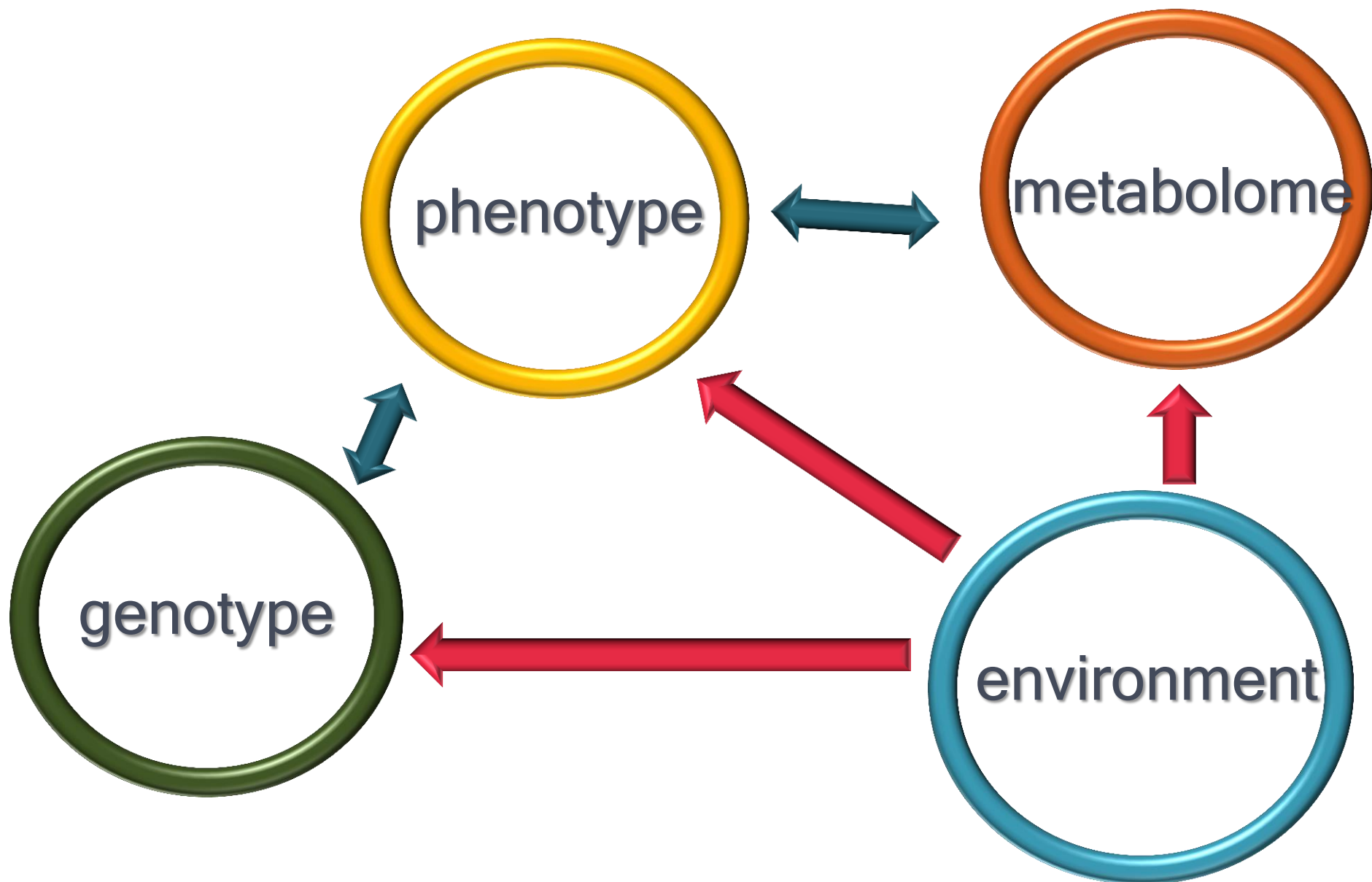
farmers

They are associated with traditional farming systems
and are not the result of premeditated crop improvement

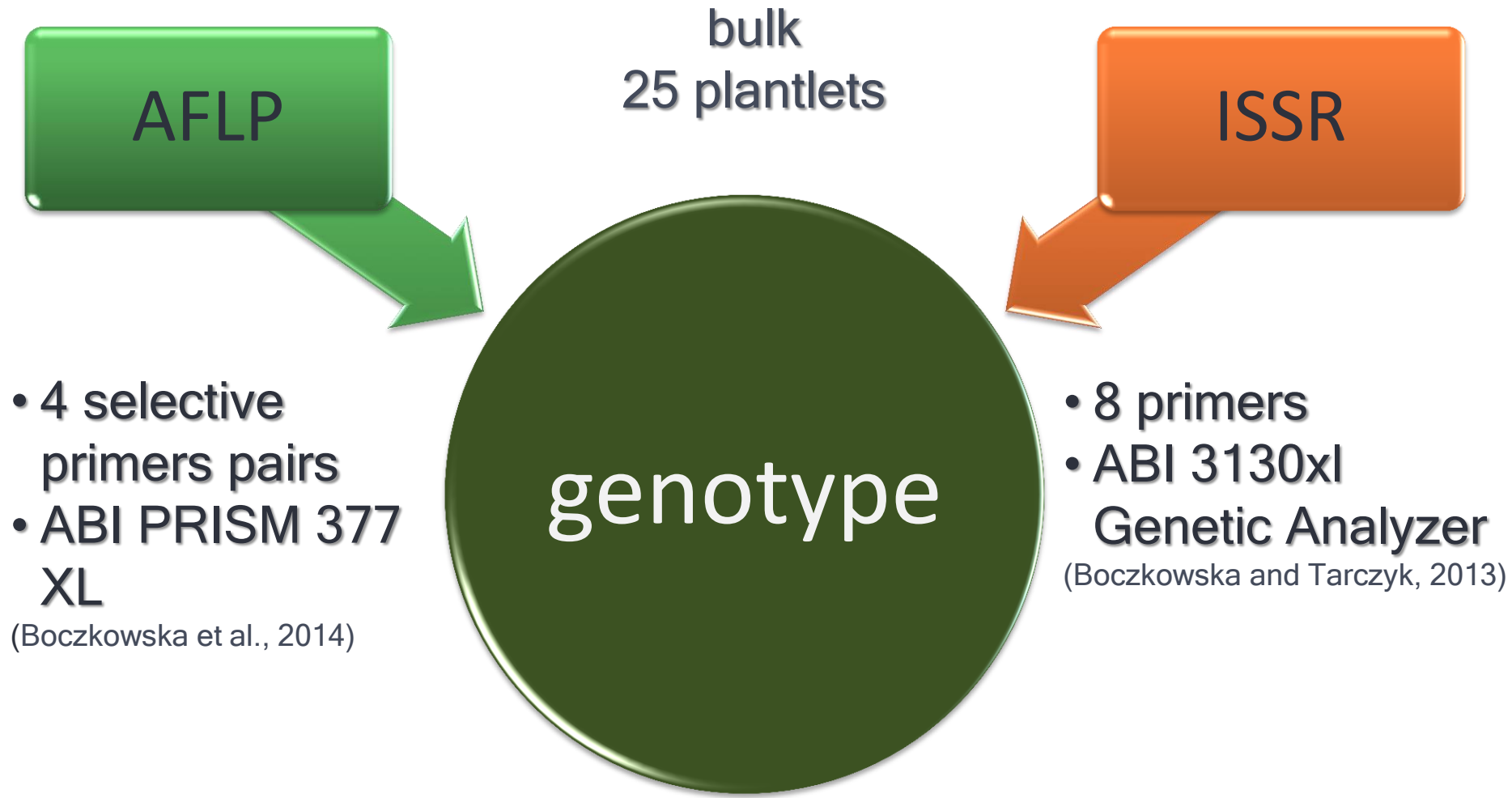
Materials

- 67 accessions
- National Centre for Plant Genetic Resources
- Poland
- 1973-1999





Methods



Methods

- botanical varieties
(Rodionova et al. 1994)

identification

morphology

evaluation

phenotype

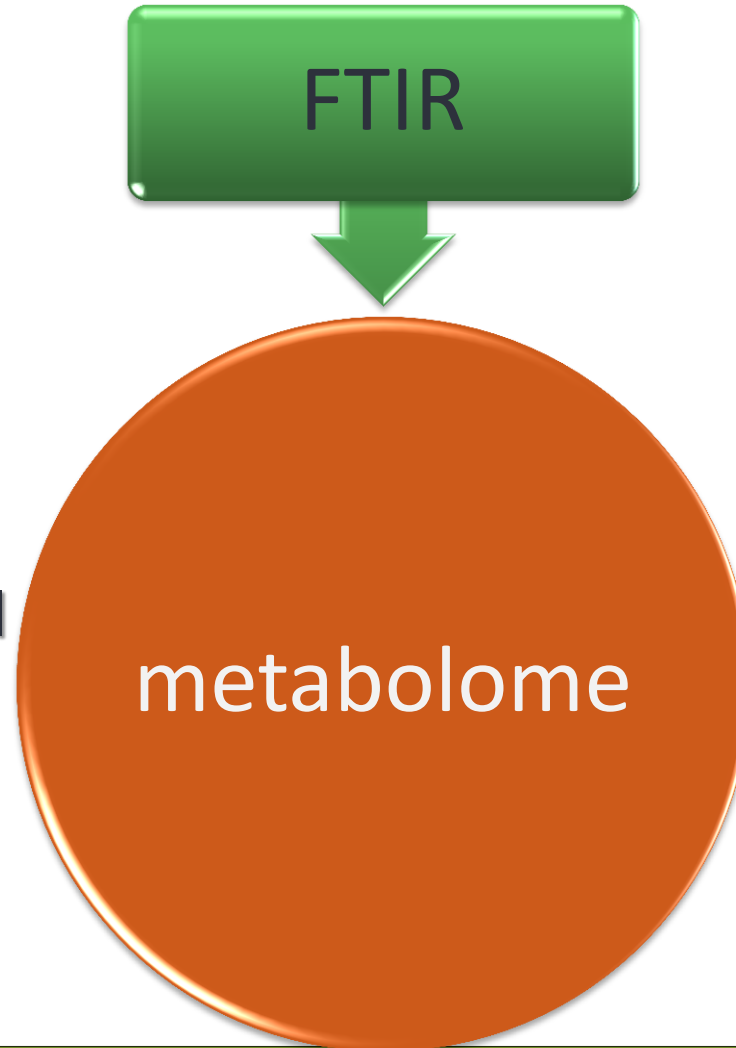
- 25 traits
 - grow habit
 - hairiness of leaf sheath
 - spirality of leaves
 - intensity of leaves spirality
 - etc.

(Boczkowska et al., 2014)

- 12 traits
 - days to maturity,
 - shoot height,
 - lodging score
 - severity of diseases
 - grain yield
 - etc.
- 3 years
(IBPGR, 1985; UPOV, 1994)

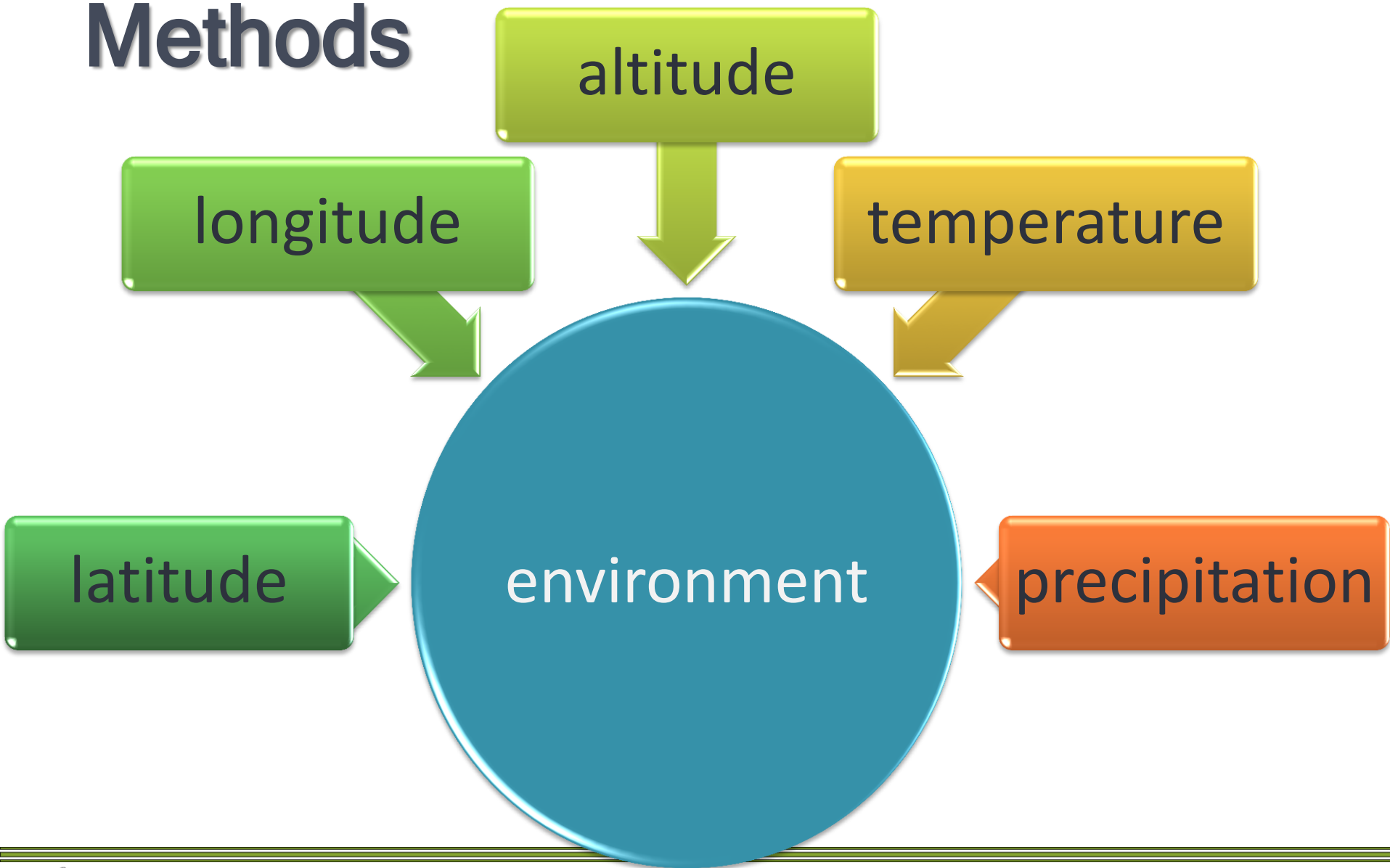
Methods

- 50 dehusked grains
- Nicolet iZ 10 module
- Smart Orbit Attenuated Total Reflectance (ATR)

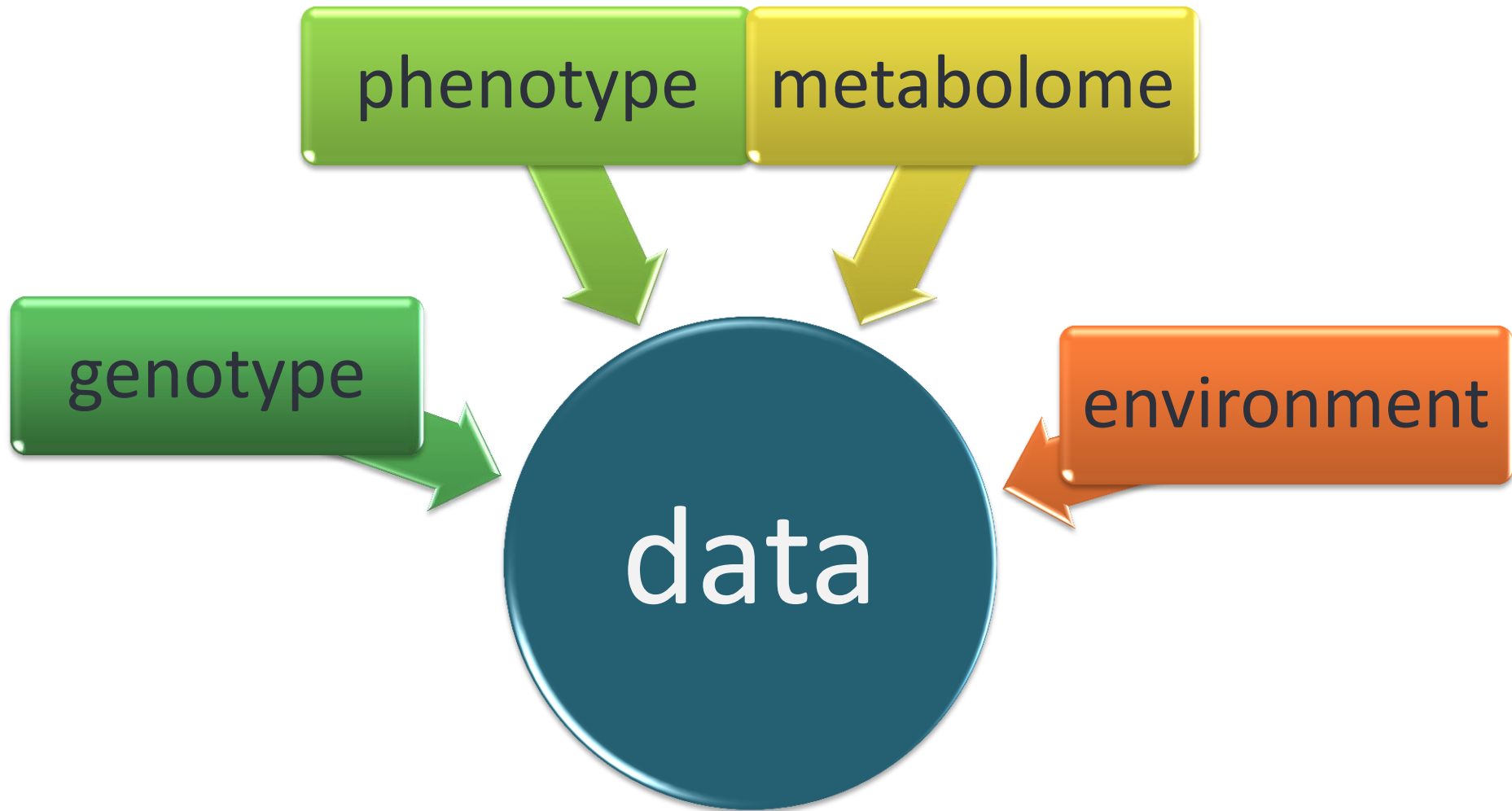


- 64 interferograms
- three biological replications
- resolution of 4 cm^{-1}
- wavenumber range between 4000 and 400 cm^{-1} .

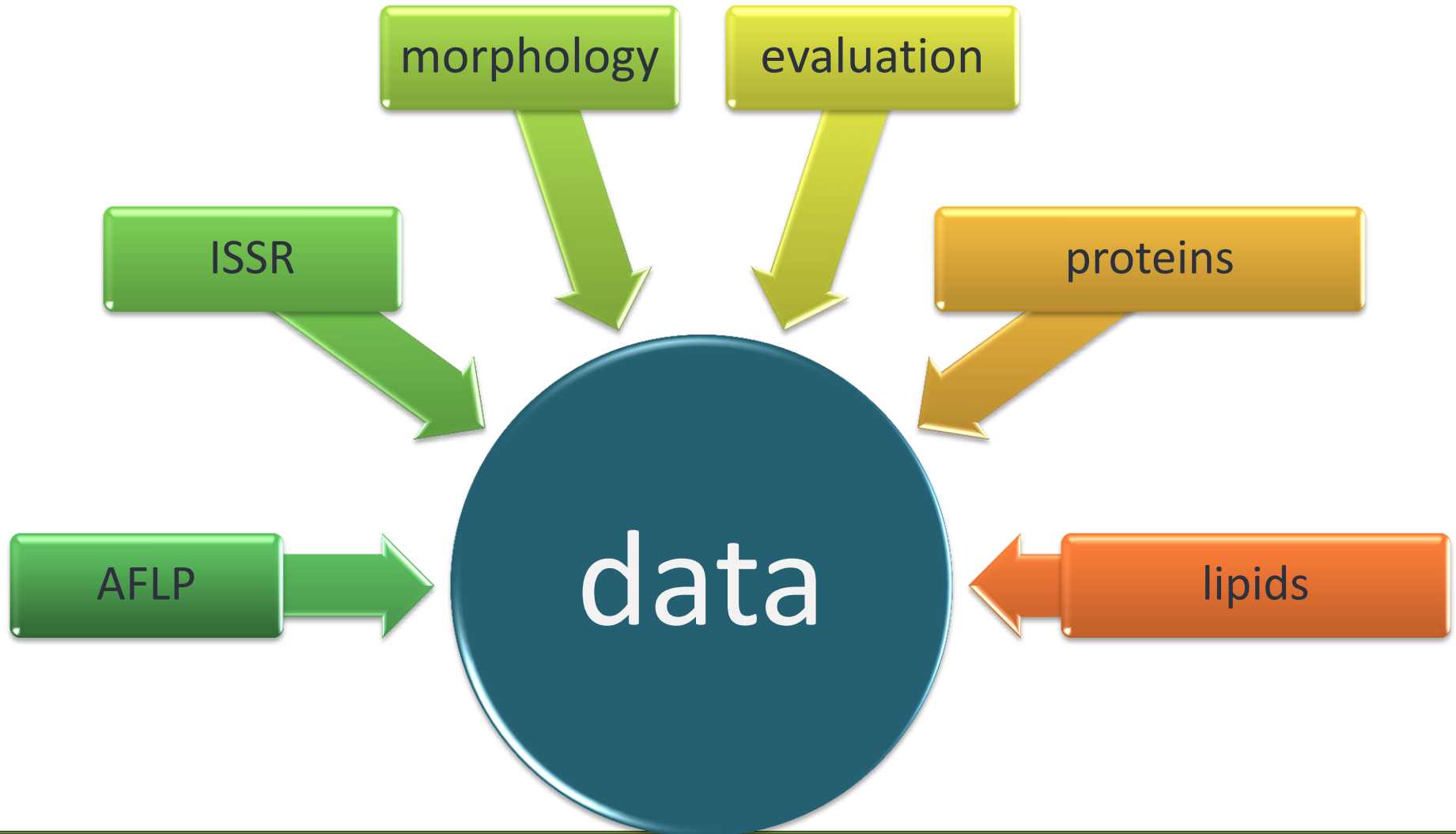
Methods



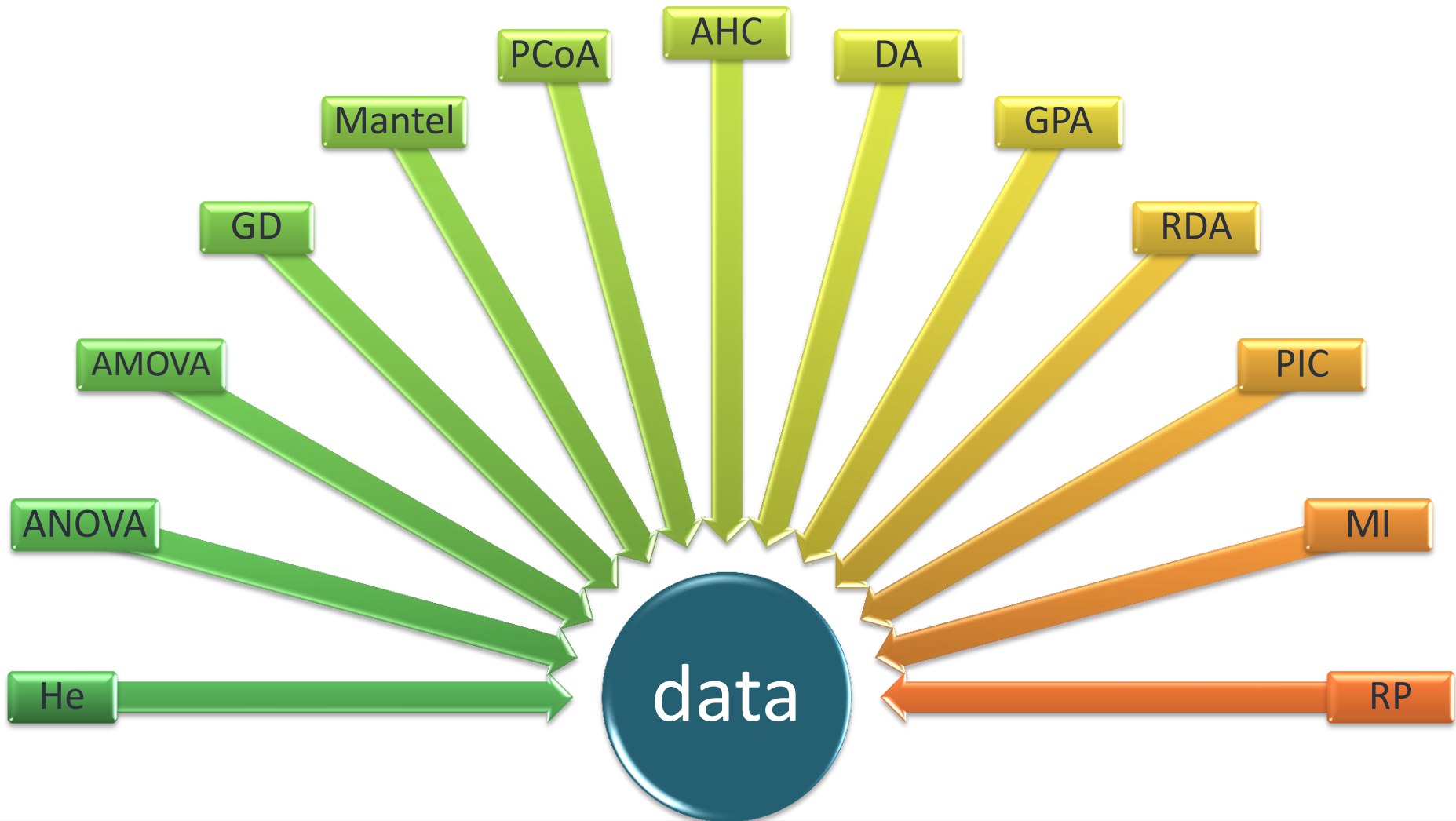
Methods



Methods

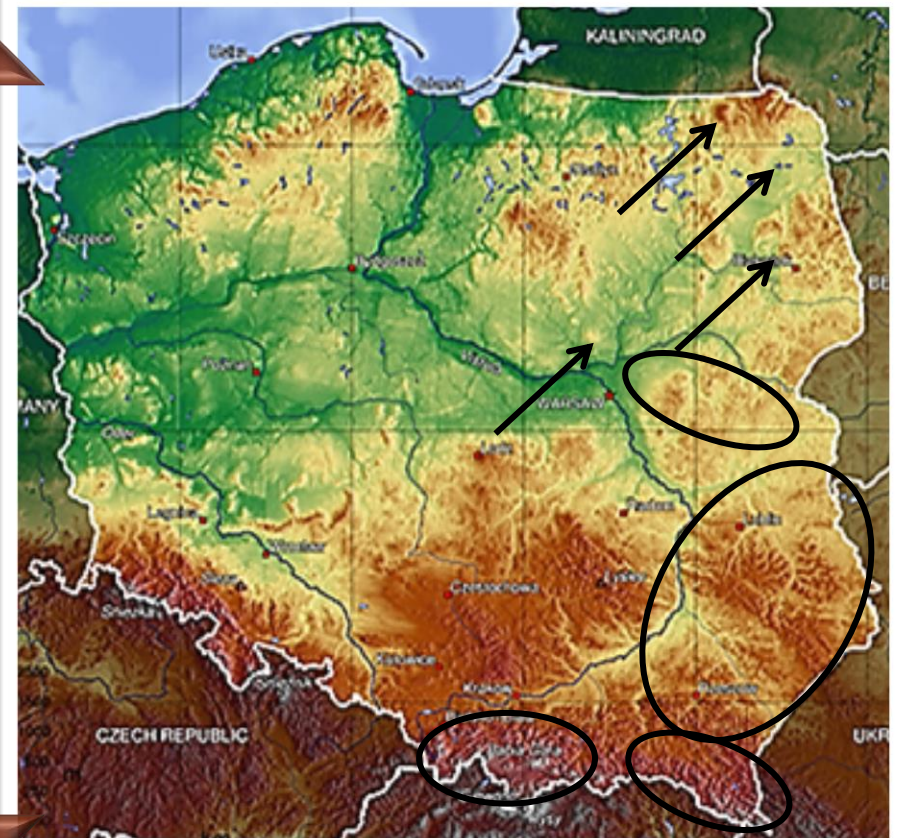


Methods



Enviroment

- latitude 49.21-54.20 N
- longitude 19.16-23.36 E
- altitude 100 to 913 mamsl
- average annual temperature 5.7-8.8°C
- average annual precipitation 535-1066 mm



Phenotype

- environmental conditions influenced both:
 - the richness of phenotypes
 - favored some morphotypes specific for a given location.
- interdependence between stalk morphology and the thousand seed weight confirmed the deliberate selection by farmers

Phenotype

- accessions collected in close proximity were characterized by a very similar appearance but quite different scores of the evaluation data -preferences of farmers
- morphological diversity ranked on the average level

Genotype

- genetic diversity was lower than phenotypic
- ISSRs better molecular system than AFLPs
- the accessions collected in a close proximity, were completely different genetically, despite morphological similarities

Genotype

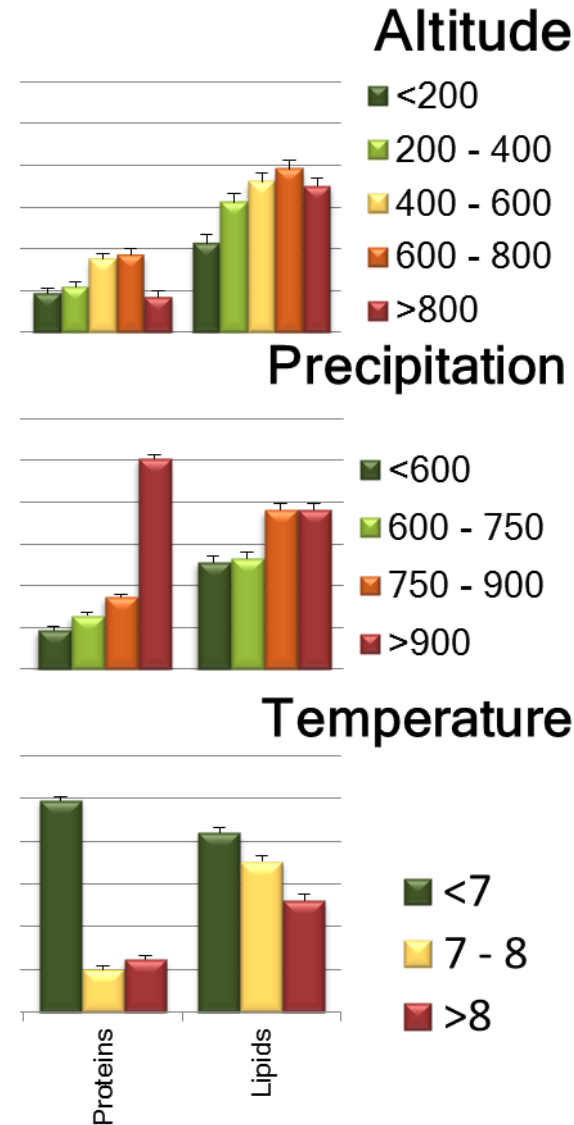
- correlation of the genetic markers with altitude, precipitation and temperature
- specific genotype patterns of the oat landraces could be influenced or even created, to a great extent, by the local environment
- changes related to the coding or non-coding genome regions?

Metabolome

- The total spectral profile did not display any statistically significant correlations with both the genotype and phenotype
- FTIR technique revealed landrace variability in relation to the altitude, annual temperature, and annual precipitation in collection sites, some of which could not be detected with other traits.

Metabolome

- All accessions were examined in the same field trials and were thus exposed to identical environment, the observed metabolomics diversity reflected specific, adaptive modifications of landrace to habitats in the place of their origin.



Lipids

- the highest variability among all tested traits.
- a weak but statistically significant correlation was established between lipids and the ISSR markers.

Proteins

- a significant correlation occurred between the protein-related spectra and both genotype and phenotypic qualitative traits
- a large group of landraces with a very high internal similarity of protein and lipid spectral profiles was identified.
- accessions collected in the same or very close location had a similar lipid profile, whereas the considerable differences were observed in proteins.

Conclusions

- Grain metabolic fingerprint derived from FTIR spectroscopy revealed the highest degree of germplasm diversity among all of the examined traits, particularly for spectral bands assigned to lipids.
- The landraces, which were collected in close geographical proximity, showed clear morphological and metabolic resemblances, although they represented quite different genetic backgrounds.

Conclusions

- All three levels of analysis showed the presence of selection resulting from environmental pressures and more specifically from the temperature at the landrace origin site.
- This research also proved that coupling of genetic polymorphism with the FTIR fingerprinting markedly extended the description of the oat landraces diversity.

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Authors

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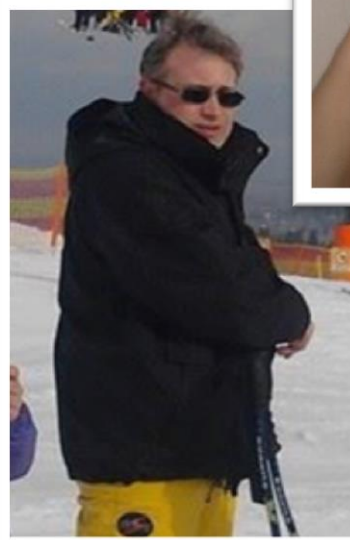
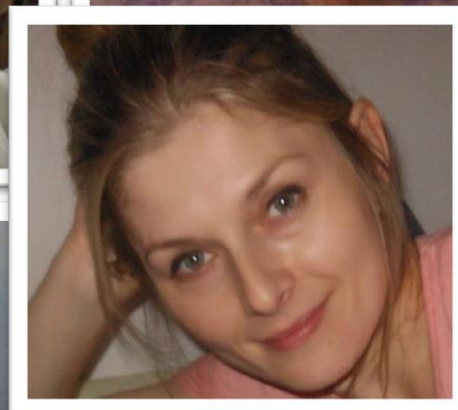
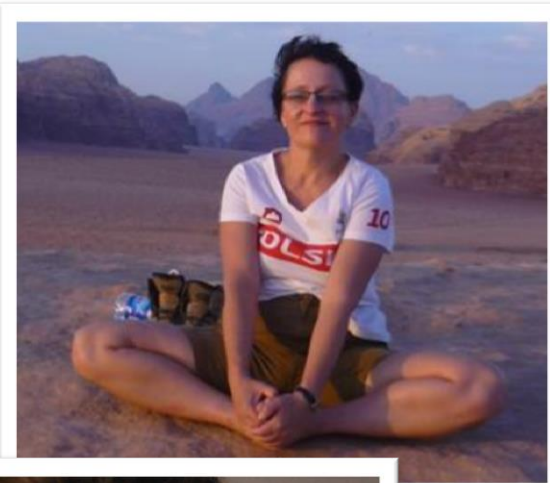
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