Genetically diverse bean materials for resilience in organic farming systems

Problem

Organic bean production under European organic conditions is challenged by variable weather, disease pressure, weed competition and yield instability. Uniform or pure-line bean varieties may perform well under specific conditions, but often show reduced resilience when exposed to environmental stress, intercropping, or low-input management.

Solution

Within the DIVERSILIENCE project, genetically heterogeneous bean materials, composite populations and diverse growth types were evaluated under organic conditions. Results from field trials and genetic analyses show how heterogeneous materials can contribute to improved adaptation, resilience and system performance compared to uniform varieties, both in sole cropping and in cereal–bean intercropping systems.

Outcome

- **Heterogeneous materials vs. pure lines:** Genetically diverse bean materials showed variable but adaptive performance under organic conditions, indicating potential for improved resilience compared to uniform pure lines.
- **Intercropping performance:** Common bean intercropping with durum wheat and winter wheat gave satisfactory cereal yields under organic conditions in Slovenia, whereas intercropping with maize reduced maize yield due to competition for light and space.
- **Yield drivers and limitations:** Weather, weed pressure and wildlife damage strongly influenced bean yields in intercropping systems, often outweighing varietal effects.
- **Trait diversity and nitrogen fixation:** Bean genotypes differed in growth habit, nodulation and seed yield. Some formed root nodules while others did not, indicating genetic variation in nitrogen fixation potential.
- **Cowpea genetic diversity:** A diverse set of cowpea genetic resources produced grain under organic conditions in Slovenia, despite large variation in flowering time, maturity and yield, confirming high adaptive diversity.
- **Link to genetic markers:** Genetic loci associated with agronomically important and resistance traits were identified, providing a basis for their potential use in heterogeneous bean materials.

Applicability box

Theme: Variety choice and cropping system design in organic grain legumes.
Geographical coverage: Temperate climates; results are generated in Slovenia, but relevant for organic bean production in comparable European conditions.
Application time: When selecting bean varieties or populations, planning sole cropping or intercropping systems, and setting up small on-farm trials.
Period of impact: Short-medium term
Farm type: Organic arable and mixed farms
Machinery: Standard arable farming equipment; no specialised machinery required.

Practical recommendations

1. **Use genetically diverse bean material:** Consider composite populations or heterogeneous varieties to support adaptation and resilience under organic conditions.
2. **Match growth type to cropping system:** Select bean growth types suited to the intended system (sole cropping or intercropping).
3. **Be cautious with maize–bean intercropping:** Expect possible maize yield reductions unless variety choice and spatial arrangement are optimized.
4. **Prioritise early weed management:** Weed competition strongly affects outcomes in organic bean systems, particularly in intercropping.

Practical testing

Farmers and advisors are encouraged to test heterogeneous bean materials alongside pure-line varieties under their own organic conditions, both in sole cropping and intercropping systems. Monitoring yield, weed pressure, nodulation and crop interactions under local conditions will help assess performance and suitability. Sharing results through Organic Farm Knowledge will support further development and refinement of genetically diverse bean materials.

Further information

Borgen, A. et al. (2025) *Characterization of genetic variation for the development of diverse and resilient crops for the organic sector*. D1.1, DIVERSILIENCE, CORE Organic Cofund.

Annicchiarico, P. et al. (2025) *Value of genetically heterogeneous crops for organic farming according to DIVERSILIENCE results, and implications for organic breeders and farmers*. D2.1, DIVERSILIENCE, CORE Organic Cofund.

Cavalli, D. et al. (2025) *Farmer-participatory design and assessment of warm-season legume cereal binary associations for southern Europe*. D3.3, DIVERSILIENCE, CORE Organic Cofund.

About this practice abstract and DIVERSILIENCE

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DIVERSILIENCE – Diversifying crops and cropping systems for resilience in organic farming (2022–2024): The project developed and tested genetically heterogeneous cereal and grain legume populations to improve yield stability, stress tolerance, and overall resilience in organic farming systems across Europe. DIVERSILIENCE combined on-farm trials, farmer-led selection, and multi-country evaluations to identify crop materials and management strategies that performed reliably under variable organic conditions. The consortium included partners from several European countries and was funded under the CORE Organic Cofund programme.

Project website:
https://projects.au.dk/coreorganiccofund/2021-call-projects/diversilience

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