For a Digital Transformation that Sustain Agricultural Ecosystems Biodiversity. Study Case: Wheat and Barley Breeding

Petcu Victor
National Agricultural Research and Development Institute-Fundulea
Centrul de Studii și Cercetări de Biodiversitate Agrosilvică "Acad. David Davidescu"

Pintilia Sabina
National Agricultural Research and Development Institute-Fundulea
University of Agronomic Sciences and Veterinary Medicine of Bucharest

Lazăr Cătălin
National Agricultural Research and Development Institute-Fundulea

Cergan Mihaela
National Agricultural Research and Development Institute-Fundulea

Simion Petruta Simona
Centrul de Studii și Cercetări de Biodiversitate Agrosilvică "Acad. David Davidescu"
Academia de Studii Economice din București

Abstract

Crop diversification is one of the most consistently supported strategies for reducing agronomic risk, improving yield stability, and increasing associated biodiversity and ecosystem services. This study reflects on modern technology loss on biodiversity, how Green Revolution altered inter- and intra-specific agrobiodiversity; whether classical breeding crossing for new varieties or inter-genus species such as triticale compensate for biodiversity loss; how wheat breeding has traded off yield, processing quality, protein, and minerals; how herbicide-tolerant cultivar platforms and mechanization have affected diversity at farm and landscape scales; and whether Agriculture 4.0 is more likely to diminish or enhance agrobiodiversity. Post-Green-Revolution agriculture simplified inter-specific diversity in fields and landscapes and often narrowed deployed intra-specific diversity through varietal replacement, large-field mechanization, and commodity-oriented seed systems, even though breeding itself continued to generate new variation. Wheat illustrates this duality especially well: modern breeding improved yield and some baking-related traits, but protein concentration and several mineral traits often declined, partly through dilution effects and partly through pleiotropic effects of semi-dwarfing alleles such as Rht-D1b; however, the evidence does not support a simplistic claim that all modern wheat is nutritionally inferior in all respects. Classical breeding innovations, including wheat–rye triticale, expanded the breeding space, but they did not automatically restore on-farm diversity because release is not the same as deployment. Agriculture 4.0 should therefore be treated as a branching pathway rather than a single destiny: if used mainly to optimize large, uniform monocultures, it will likely reinforce simplification; if designed for biodiversity monitoring, heterogeneous landscapes, cultivar mixtures, longer rotations, and small autonomous machinery, it could become an important enabler of agrobiodiversity restoration.

Keywords

Crop diversification, agrobiodiversity, inter-specific diversity, modern breeding.