Market Power in the Seed Sector: Challenges to Innovation, Diversity, and Food Security

Authors: Mahdi Rafati; Sobhan Barati; Alireza Karbasi

Corresponding author: karbasi@um.ac.ir

Abstract

The global seed industry has shifted from a "Big Six" to a "Big Four" structure, sparking worries about inflated prices, reduced options for farmers, and stifled long-term innovation (OECD, 2018; Deconinck, 2020). While germplasm markets show some competition, trait markets are often more concentrated, leading regulators to approve mega-mergers like Bayer-Monsanto and Dow-DuPont only after imposing safeguards to maintain competition and research vitality (European Commission, 2017; European Commission, 2018). Research on innovation outcomes remains inconclusive, yet modern breeding techniques, including genetically modified (GM) traits, have generally boosted productivity and reduced input needs (Klümper & Qaim, 2014; Duvick, 2005). In Iran, reliance on imports, intellectual property (IP) regulations, and certification inefficiencies shape how market power affects access, costs, and crop variety (Karbasi et al., 2019; Moslemkhani et al., 2018; Islamic Republic of Iran, 2003/2008). This article synthesizes evidence to highlight policy paths forward.

Introduction

High-quality seeds and diverse varieties form the backbone of agricultural productivity, resilience, and global food security. However, increasing market concentration threatens these foundations by limiting choices and driving up costs without adequate protections (OECD, 2018; Deconinck, 2020). Globally, the homogenization of food supplies amplifies risks, underscoring the importance of pluralistic seed systems and strong ties between conservation and use (Khoury et al., 2014; FAO, 2019). In Iran, the Seed & Seedling Law and its bylaws govern registration, certification, and IP enforcement, creating barriers to entry while incentivizing innovation (Islamic Republic of Iran, 2003/2008). Building on this context, we explore how these dynamics play out amid consolidation trends.

Methodology

We conducted a structured evidence synthesis covering 2000–2025, searching multiple databases including Web of Science, Scopus, Google Scholar, and Persian platforms like ISC/SID for terms related to seed market concentration (e.g., Herfindahl-Hirschman Index [HHI] and concentration ratios [CR]), pricing, innovation/research and development (R&D), IP (UPOV/TRIPS), biodiversity, and Iran's governance. After screening, we focused on peer-reviewed studies with DOIs and official reports from bodies like OECD, FAO, European Commission, and Majles, prioritizing cross-country, longitudinal, structural price/demand models, and meta-analyses. Key outcomes extracted included concentration levels, pricing effects, innovation trends, productivity gains, biodiversity impacts, and regulatory efficacy. To ensure relevance to Iran, we incorporated Persian DOIs for localized insights (Karbasi et al., 2019; Moslemkhani et al., 2018; Mirzaei-Heidari & Bagheri, 2022; Ghaderi-far et al., 2017; Moghani & Zaheri, 2023).

Results

Market consolidation has driven up concentration ratios, particularly in traits, prompting competition authorities to mandate divestitures and innovation safeguards in mergers like Bayer-Monsanto and Dow-DuPont to sustain rivalry (OECD, 2018; European Commission, 2018; European Commission, 2017; Deconinck, 2020). Yet, impacts vary by crop and region, with structural pricing analyses revealing how trait bundling inflates seed costs and reduces alternatives in U.S. corn and cotton markets (Shi et al., 2010; Shi et al., 2011). Similarly, demand models highlight lock-in effects from switching costs in U.S. soybeans, illustrating how market power influences farm-level choices (Luo et al., 2023). On the positive side, meta-analyses show GM adoption enhances yields and profits while cutting pesticide use, especially in developing nations, complemented by steady genetic gains from traditional breeding (Klümper & Qaim, 2014; Duvick, 2005). However, biodiversity threats from dietary homogenization demand safeguards for diverse germplasm and farmer-led systems (Khoury et al., 2014; FAO, 2019). Turning to Iran, gravity models indicate that seed imports rise with partner market size and IP commitments but fall with distance, positioning trade and IP as key influencers of access and pricing (Karbasi et al., 2019). The legal and certification framework, including the Seed and Plant Certification and Registration Institute (SPCRI), establishes national standards, but issues like Potato virus Y (PVY) outbreaks in potatoes undermine trust and effectiveness if unaddressed (Islamic Republic of Iran, 2003/2008; Moslemkhani et al., 2018). Persian studies stress seed production's role in self-sufficiency, advocating for public research missions and robust public-private partnerships that intersect with competition and IP dynamics (Mirzaei-Heidari & Bagheri, 2022; Ghaderi-far et al., 2017). Legal analyses in Iran warn that skewed IP protections may restrict smallholders' seed reuse and exchange, with broader equity and diversity consequences (Moghani & Zaheri, 2023).

Conclusion

To address these challenges, policymakers should foster contestable markets through rigorous merger oversight and scrutiny of tying or exclusive licensing. Balancing IP with exemptions for breeders and farmers, plus open or fair, reasonable, and non-discriminatory (FRAND) licensing, can support ongoing innovation. Public investments in pre-breeding, testing, and open trials are essential, alongside bolstering certification through better surveillance, diagnostics, and transparency. Finally, ongoing monitoring of prices, variety turnover, trait access, and biodiversity—beyond just HHI/CR metrics—will ensure sustainable outcomes (OECD, 2018; European Commission, 2017; European Commission, 2018; FAO, 2019; Islamic Republic of Iran, 2003/2008).

Acknowledgements

Distribution of the global seeds market value in 2012, by country

Country	Market value share
United States	26.71%
China	22.15%
France	6.23%
Brazil	5.84%
Canada	4.72%
India	4.45%
Japan	3.01%
Germany	2.6%
Argentina	2.2%
Italy	1.71%

Source
International Seed Federation
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Additional Information:
Worldwide