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When technology restructures the fields: Rising wages, herbicide adoption, and the masculinisation of agricultural employment in India

MAXWELL MKONDIWA¹, VIJAYALAXMI KHED², VIJESH KRISHNA³

¹*International Maize and Wheat Improvement Center (CIMMYT), Sustainable Agrifood Systems (SAS),*

²*International Maize and Wheat Improvement Center (CIMMYT), Sustainable Agrifood Systems (SAS),*

³*International Maize and Wheat Improvement Center (CIMMYT), Sustainable Agri-food Systems, India*

Abstract

Labour-saving agricultural technologies are expanding rapidly across South Asia, driven partly by rising rural wages and seasonal labour scarcity. Yet the distributional consequences of this expansion for socially stratified rural workforces remain poorly understood, particularly when gender and caste intersect to govern who performs which agricultural tasks. This paper examines how herbicide diffusion in Bihar – India’s most agrarian and among its poorest states – reshapes the entire task composition of cereal farming, with consequences that extend well beyond the displacement of manual weeding labour.

Using rural wage data from 2006–2020 alongside two farm-household surveys covering rice, wheat, and maize production across 35 districts and over 2,400 households, we document a self-reinforcing dynamic: rising women’s wages, which remain persistently below men’s throughout the study period, possibly have incentivised farmers to adopt herbicides as a labour substitute, but adoption subsequently forecloses the primary income-generating activity for the very women whose rising wages triggered it. Crop-specific multinomial logit estimates confirm that female labourers from Scheduled Caste and Scheduled Tribe households are less likely than their male counterparts to be involved in chemical weeding operations (the expanding task) while being significantly more concentrated in manual weeding (the contracting one).

More strikingly, an analysis of seven complementary on-farm tasks – land levelling, land preparation, sowing, fertiliser application, irrigation, harvesting, and threshing – reveals that herbicide adoption is associated with expanding male labour demand in fertiliser application and irrigation, while female labour registers no meaningful gains in any of the seven activities examined. This pattern constitutes a systematic masculinisation of the complementary task landscape, not merely a displacement from weeding. The net result is a contraction of women’s on-farm presence across the production calendar, not a reallocation within it.

These findings carry direct implications for the design of agro-ecosystem interventions that aim to be both productive and socially inclusive: technologies that raise system-level efficiency while systematically narrowing labour opportunities for already-marginalised groups challenge the premise that productivity-oriented agricultural transformation is inherently pro-poor. Embedding gender- and caste-disaggregated task assessments into ex-ante technology evaluation frameworks is a tractable first step toward more equitable agro-ecosystem transitions.

Keywords: Caste, gender, herbicide adoption, intersectionality, labour displacement, labour-saving technologies, rural India, task reinstatement