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Gender-disaggregated analysis of technology adoption rates resulting from extension demonstration programs

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Abstract

While women make up nearly half the agricultural labor force in South Korea's rural provinces, their participation in extension demonstration programs and subsequent technology adoption have rarely been measured separately from men's. This research conducted a gender-disaggregated analysis of technology adoption rates among 306 farmers (147 women and 159 men) who attended extension demonstration events in Chungcheongnam-do Province between April 2022 and August 2023. Five technology categories were tracked: crop management tools, post-harvest equipment, irrigation techniques, improved seed varieties, and soil testing kits. Overall adoption rates were 58.5% for women and 64.8% for men, with the gender gap narrowing to non-significant levels for seed varieties and post-harvest equipment. Women showed significantly lower adoption of irrigation techniques (23.1% vs. 41.5%, $p < 0.01$) and soil testing kits (19.7% vs. 34.0%, $p < 0.05$). Land tenure insecurity and lower access to credit were the leading barriers specific to women adopters.

Keywords: Gender analysis, technology adoption, extension demonstration, women farmers, adoption rates, agricultural technology, gender gap, South Korea, crop management, disaggregated data

Introduction

Men and women attend the same extension demonstrations, hear the same advice, and observe the same technologies yet their adoption outcomes often diverge sharply. This contrast between equal exposure and unequal uptake is one of the persistent puzzles in agricultural extension research ^[1]. Across Asia, gender-disaggregated adoption data remain scarce because most extension monitoring systems track households rather than individuals, effectively hiding within-household differences in who actually uses the technologies being promoted ^[2, 3].

South Korea's agricultural sector has undergone rapid transformation, with an aging and increasingly feminized farming workforce. Women now account for roughly 47% of farm operators in rural provinces, yet extension programming continues to be designed without systematic attention to gender-specific adoption patterns ^[4, 5]. Chungcheongnam-do Province, one of the country's major rice and vegetable production areas, runs an active demonstration program through its Agricultural Technology Center network, offering an opportunity to examine whether gender influences technology uptake when both groups have equivalent demonstration access ^[6].

This research tracked adoption rates among individual women and men who attended the same extension demonstrations, disaggregated by technology type, and identified the factors that explain gender-based adoption differences ^[7, 8].

Instrument development and validation

A structured adoption tracking questionnaire was developed

for this research, drawing on items from validated instruments used in East Asian extension research ^[9]. The initial 38-item draft was reviewed by a panel of five experts (two extension researchers, two gender specialists, and one practicing extension officer) for content validity. Items were scored on a four-point relevance scale, and the Content Validity Index (CVI) reached 0.87. The instrument was pilot-tested with 28 farmers (14 women, 14 men) outside the main sample in neighboring Sejong City. Based on pilot feedback, three ambiguous items were revised and two redundant items removed, yielding a final 33-item questionnaire. Internal reliability (Cronbach's alpha) for the adoption and barrier subscales was 0.81 and 0.79 respectively ^[10].

Materials and Methods

Materials

This research was carried out through the College of Agriculture, Chungnam National University, Daejeon, South Korea, between April 2022 and August 2023. Ethical approval was granted by the Chungnam National University Institutional Review Board (Protocol CNU-IRB-2022-AG-015, approved March 10, 2022). The sampling frame included all individuals who attended at least one extension technology demonstration event organized by the Provincial Agricultural Technology Center during the research period. From attendance records of 1,247 participants across 24 demonstration events, a stratified random sample of 306 individuals (147 women, 159 men) was drawn, with

stratification by gender and technology category to ensure balanced representation ^[11].

Methods

Adoption was measured as a binary variable (adopted/not adopted) for each technology category, assessed 6-12 months after demonstration attendance. Surveys were administered through face-to-face interviews between March and June 2023. Chi-square tests compared adoption rates between genders for each technology category. Binary logistic regression modeled the influence of gender, farm size, land tenure status, credit access, education, and age on adoption. Separate models were run for each technology category. Barrier analysis used ranked frequency counts

from a closed-list barrier section. All analyses used R version 4.3.1 ^[12].

Ethical considerations

All participants provided written informed consent. Questionnaires were administered in Korean, and participants were assured that individual responses would remain confidential. Women participants were offered the option of a female interviewer if preferred. No compensation was provided for participation, though respondents received informational brochures on available extension programs. Data were stored on encrypted university servers with access limited to the research team.

Results

Table 1: Technology adoption rates by gender across five demonstration categories (n = 306)

Technology Category	Women (%)	Men (%)	Gap (pp)	p-value
Crop management tools	52.4	58.5	-6.1	0.287
Post-harvest equipment	47.6	51.6	-4.0	0.491
Irrigation techniques	23.1	41.5	-18.4	0.001
Improved seed varieties	68.7	72.3	-3.6	0.498
Soil testing kits	19.7	34.0	-14.3	0.006
Any technology (overall)	58.5	64.8	-6.3	0.257

The overall gender gap in adoption (6.3 percentage points) was not statistically significant. However, significant gaps appeared for irrigation techniques (18.4 pp, p = 0.001) and

soil testing kits (14.3 pp, p = 0.006). Seed variety adoption was nearly equal between genders ^[13, 14].

Table 2: Adoption barriers reported by women and men farmers

Barrier	Women (% n=147)	Men (% n=159)
Land tenure insecurity	44.9	16.4
Limited credit access	39.5	21.4
Equipment too physically demanding	31.3	8.2
Insufficient follow-up training	27.2	24.5
Lack of decision-making authority	22.4	3.1

Women reported starkly different barrier profiles than men. Land tenure insecurity and limited credit access structural constraints rather than technical ones were the top barriers

for women. Men’s barriers were more evenly distributed and less gender-specific ^[15, 16].

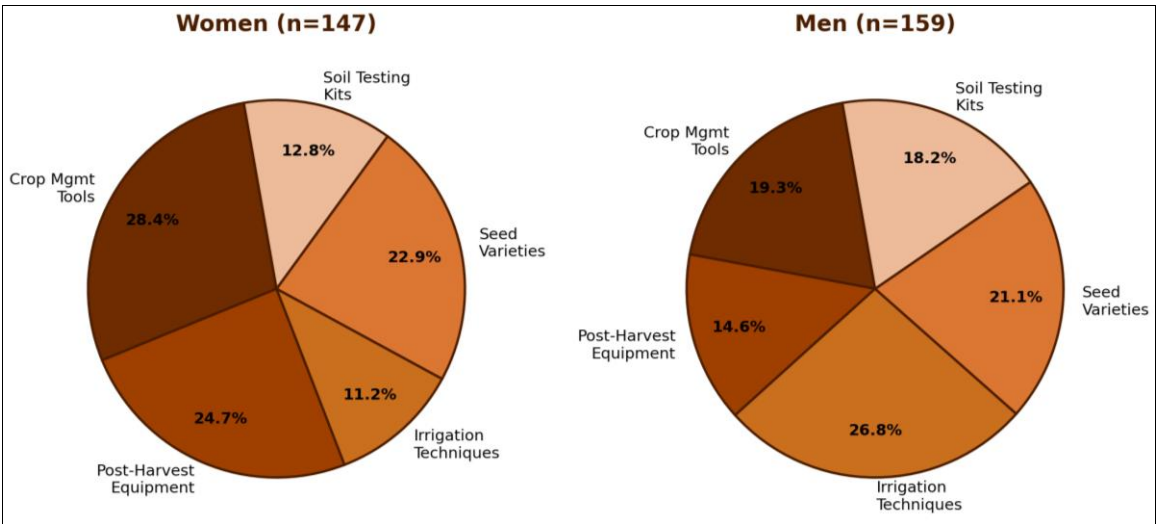


Fig 1: Gender-disaggregated distribution of technology adoption across five extension demonstration categories

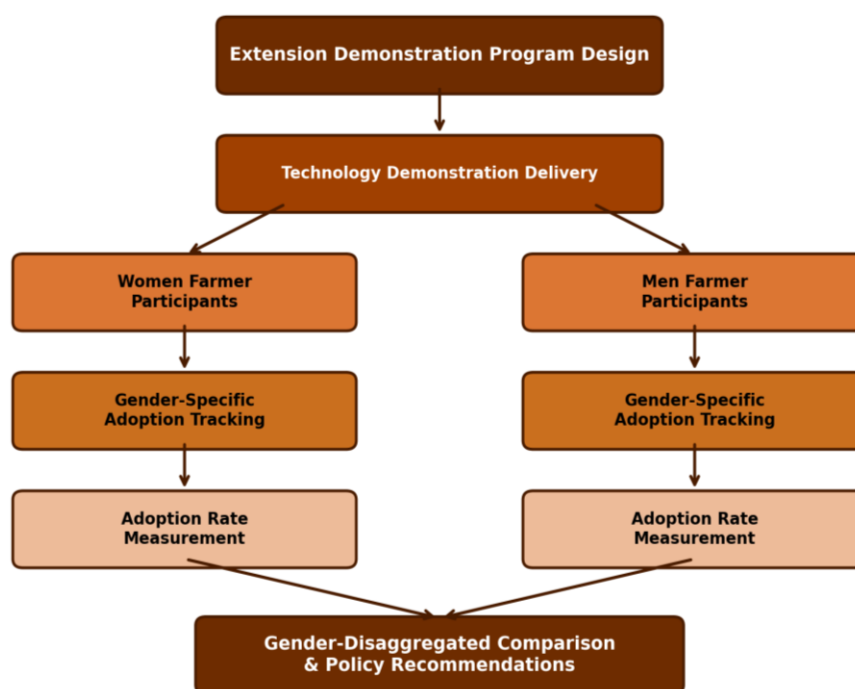


Fig 2: Extension demonstration program design and gender-disaggregated evaluation pathway

Comprehensive interpretation

The results reveal that gender adoption gaps are technology-specific rather than universal. Technologies requiring capital investment and secure land tenure (irrigation, soil testing) showed significant gender gaps, while those with lower entry costs and more immediate returns (seed varieties, post-harvest tools) did not. This pattern suggests that structural economic constraints, not lack of interest or technical ability, drive women's lower adoption for certain technology categories.

Discussion

The finding that overall adoption rates didn't differ significantly between genders when aggregated across all technologies masks important category-specific gaps that only become visible through disaggregated analysis. This underscores why extension monitoring systems need to move beyond household-level reporting ^[2]. The 18.4 percentage point gap in irrigation technique adoption echoes findings from Southeast Asia where women's lower land ownership limited their investment in fixed-infrastructure technologies ^[17].

Land tenure insecurity emerged as the barrier most strongly differentiated by gender (44.9% of women vs. 16.4% of men). In South Korea's rural property registration system, farmland is frequently registered under male household heads even when women are the primary operators, creating a disconnect between management responsibility and asset control ^[18]. Extension programs cannot solve land tenure issues directly, but they can mitigate the adoption consequences by promoting technologies that don't require land-based investment such as improved seeds and mobile soil testing services as entry points for women ^[19, 20].

Limitations

The research was confined to a single province, limiting generalizability to areas with different agricultural

structures. Adoption was measured as a binary variable, which doesn't capture intensity or consistency of use. The 6-12 months post-demonstration measurement window may be too short to assess sustained adoption. Selection bias is possible since the sample was drawn from demonstration attendees, who may differ from the broader farming population in motivation and resource endowment.

Conclusion

Gender-disaggregated tracking reveals adoption gaps that aggregated data conceal. While overall adoption rates between women and men in South Korea's extension demonstrations were statistically similar, significant gaps appeared for technologies requiring capital investment and secure land tenure. Women's adoption barriers are primarily structural land tenure insecurity, limited credit, and constrained decision-making authority rather than technical. Extension programs should integrate gender-disaggregated monitoring as standard practice, prioritize low-barrier-to-entry technologies for women's initial engagement, and coordinate with credit and land administration agencies to address the structural constraints that limit women's technology uptake.

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