

CROP MANAGEMENT PRACTICES AND GRAIN YIELD IN TEFF, WHEAT AND MAIZE UNDER VIDEO-MEDIATED EXTENSION THROUGH ORAL AND ARTISTIC MEDIATION

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Abstract

Video-mediated extension may support crop management, but grain yield depends on practices implemented in farmers' fields. Endline data from 1,892 households were linked with field and crop-production records. The primary sample comprised 2535 sole-crop household-crop-season observations for teff, wheat and maize. Area-weighted indicators represented fertilizer, improved seed, manure and repeated weeding. Complete fertilizer-area coverage versus none was associated with 33% higher adjusted yield (95% CI 18.3-49.6), while each one-point increase in a four-practice management-intensity score was associated with 6.3% higher yield (1.4-11.4). The intensity association was strongest for teff (13.1%, 4.3-22.7). Video attendance was not independently associated with pooled yield. Among 2,507 attended video-topic records, discussion (OR 2.08) and similarity to featured farmers (OR 1.48) were associated with reported adoption. Crop-specific management and facilitated, relatable extension may be complementary, although the associations are not causal.

Introduction

Teff (*Eragrostis tef* [Zucc.] Trotter), wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.) are major cereals in Ethiopia, where farm yield is constrained by heterogeneous soils, nutrient limitations and uneven access to effective crop-management inputs. Recent Ethiopian studies show that fertilizer response varies with crop, soil, landscape and application strategy, and that improved seed, balanced nutrients and integrated soil-fertility management can raise productivity when they are matched to local conditions (Ahmed 2022, Dargie *et al.* 2022, Mosisa *et al.* 2022, Seifu *et al.* 2022, Adem *et al.* 2023, Elias *et al.* 2023, Gedamu *et al.* 2023, Loha *et al.* 2023, Tufa 2023, Mohammed *et al.* 2024). Evidence from sub-Saharan Africa likewise emphasizes that fertilizer benefits depend on nutrient balance, soil health and complementary management rather than input use alone (Dimkpa *et al.* 2023, Zheng *et al.* 2024).

These agronomic responses make adoption of a single practice an incomplete indicator of crop management. A field may simultaneously receive mineral fertilizer, improved seed, organic amendments and repeated weeding, while another may receive only one of these practices. Technology-combination studies in Ethiopia have reported larger maize benefits when improved seed and fertilizer or inorganic and organic fertility practices are used together than when they are adopted in isolation (Ahmed 2022, Adem *et al.* 2023, Tufa 2023). At the same time, farmer-level survey estimates cannot be interpreted as controlled agronomic treatment effects because management choices are related to resources, extension access and production conditions (Mohammed *et al.* 2024). Analyses that connect observed field management with crop-specific yield should therefore distinguish adjusted associations from causal responses.

Digital agricultural extension provides another layer in this pathway. Digital and video-based approaches can broaden access to agricultural advice, demonstrate practices visually and support interaction around management decisions (Javaid *et al.* 2022, Abate *et al.* 2023, Abiri *et al.* 2023,

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Getahun *et al.* 2024). Experimental evidence indicates that video or digitally mediated advice can improve knowledge and technology uptake, but yield responses are not uniform and often depend on context and implementation (Abate *et al.* 2023, Baul *et al.* 2024, Waje *et al.* 2024, Beach *et al.* 2025). Joint participation and facilitated discussion may also influence how information is interpreted and acted upon, while relatable messengers may make recommendations appear more feasible (Friedson-Ridenour *et al.* 2025).

The present study used a public 2023 Ethiopian endline survey to integrate two components that are usually analyzed separately: actual field-level crop-management practices and video-extension engagement. The objectives were to (i) describe fertilizer, improved-seed, manure and repeated-weeding patterns in teff, wheat and maize; (ii) quantify adjusted associations between these practices, a management-intensity measure and grain yield; and (iii) examine whether discussion and credibility-related perceptions during attended video topics were associated with reported crop-management adoption. The analysis was designed as an observational secondary study; because intervention assignment was not released with the public endline files, no programme-treatment effect is claimed.

Materials and Methods

The analysis used the public endline files for the Impact Evaluation of a Video-based Nutrition Sensitive Agriculture Intervention in Ethiopia (Buehren and Sheth 2026). Data were collected from August to October 2023 by computer-assisted face-to-face interview. The endline contained 1,892 households in 96 kebeles across eight Agricultural Growth Program phase 2 woredas in Oromia and the Southern Nations, Nationalities and Peoples region. Of these, 1,309 households had also participated at baseline, while 583 were additional listed households. Areas that could not be revisited because of insecurity were not represented in the endline.

Crop-production records were linked within anonymized households to Meher and Belg field rosters. Harvested quantity was standardized in kilograms and divided by field area in hectares, then expressed as t/ha. The analysis was restricted to teff, wheat and maize. Because crop-production quantities were recorded at household-crop-season level whereas some fields listed more than one crop, household-crop-season observations containing any multi-crop field were excluded from the primary yield analysis. Records with non-positive yield were excluded, as was one observation above 20 t/ha because of extreme leverage. The resulting primary sample contained 2,535 household-crop-season observations from 1,481 households in 95 kebeles.

Actual field management was derived from the Meher and Belg field rosters. Four binary practices were harmonized between seasons: use of chemical fertilizer, use of improved seed, application of animal manure and repeated weeding. Where a household cultivated more than one sole-crop field of the same cereal in a season, each practice was aggregated as the proportion of crop area receiving that practice. A management-intensity score was then calculated as the sum of the four area shares and ranged from 0 to 4; a one-point increase therefore represents the equivalent of one additional practice applied across the entire crop area, or an equivalent combination of partial-area practices. Repeated plowing/tillage was recorded but excluded from the index because it was nearly universal (>97% of crop area in all three cereals), providing little discriminatory information.

Video exposure and communication measures came from the household and intervention-topic files. Any video attendance was coded from the household-head report. Six crop-management topics were retained: seeding or planting, fertilizer, land preparation, weeding, pest control and storage. For an attended topic, engagement was defined as any reported discussion

after viewing with a spouse or another person, and reported adoption indicated that the respondent stated that the practice had been applied. Perceived similarity to the featured farmer was reverse-coded from 1 (very different) to 4 (very similar). Agreement with information provided by the development agent ranged from 1 (not at all) to 4 (high). These single items were treated as credibility-related perceptions and were not combined into a psychometric credibility scale.

Descriptive statistics included counts, percentages, medians, interquartile ranges, means and standard deviations. Grain yield was log-transformed because of right-skewed farm distributions. The primary pooled ordinary-least-squares model included the four area-weighted management practices and adjusted for crop, season, region, any video attendance and development-agent information agreement. A second pooled model replaced the four individual practices with the management-intensity score, and the same score was then analysed separately for maize, teff and wheat. Regression coefficients were transformed to percentage differences as $100[\exp(\beta)-1]$. Crop-specific individual-practice models were treated as exploratory. Topic-level adoption was analysed with a binomial generalized linear model including discussion, featured-farmer similarity, development-agent information agreement and topic fixed effects; odds ratios were obtained by exponentiation. For visualization, marginal predicted adoption probabilities were estimated for similarity scores 1-4 by discussion status, averaging over the observed topic and development-agent agreement distributions; 95% confidence bands were obtained from 800 draws from the asymptotic coefficient distribution defined by the kebele-clustered covariance matrix. Standard errors were clustered by anonymized kebele, all tests were two-sided and 95% confidence intervals are reported. Sensitivity analyses winsorized grain yield within crop at the 1st and 99th percentiles and applied the Benjamini-Hochberg false-discovery-rate procedure to the 12 exploratory crop-specific practice coefficients. Analyses were conducted in Python using pandas and statsmodels. The public-use files were anonymized; this secondary analysis involved no participant contact, attempted no re-identification and reports only aggregate statistics.

Results and Discussion

The target-cereal files contained 1,522 households and 2,798 household-crop-season observations before primary restrictions; 2,535 observations remained in the sole-crop yield sample (Table 1). Median yield was 1.49 t/ha for maize, 0.80 t/ha for teff and 1.60 t/ha for wheat. Yield distributions were right-skewed and differed between Belg and Meher within crops (Fig. 1a). Management profiles differed markedly among crops. Chemical fertilizer covered, on average, 40.6% of maize area, 59.8% of teff area and 92.7% of wheat area, whereas improved seed covered 20.9, 11.6 and 26.7%, respectively. Manure was most common in maize (24.0% of area), and repeated weeding covered 95.2% of maize, 83.8% of teff and 71.4% of wheat area. These contrasts support crop-specific analysis rather than a single undifferentiated management measure. They are also consistent with Ethiopian evidence that nutrient and seed responses vary substantially with crop and production environment (Dargie *et al.* 2022, Seifu *et al.* 2022, Elias *et al.* 2023, Gedamu *et al.* 2023, Mohammed *et al.* 2024).

Table 1. Analytical sample, grain yield and crop-management profile for maize, teff and wheat in Ethiopia, 2023.

Panel A. Analytical sample

Characteristic	n	Definition
Endline households	1,892	Survey sample
Households growing a target cereal	1,522	Maize, teff or wheat
Household-crop-season records	2,798	Before primary restrictions
Primary yield records	2,535	Sole-crop, $0 < \text{yield} \leq 20$ t/ha
Households in primary sample	1,481	At least one primary crop-season record

Kebele clusters			95	Cluster-robust inference			
Panel B. Crop yield and area-weighted management profile							
Crop	n	Yield median (IQR), t/ha	Fertilizer area (%)	Improved seed area (%)	Manure area (%)	Repeated weeding area (%)	Management intensity
Maize	964	1.49 (0.90-2.00)	40.6	20.9	24.0	95.2	1.81
Teff	877	0.80 (0.53-1.20)	59.8	11.6	7.7	83.8	1.63
Wheat	694	1.60 (1.07-2.40)	92.7	26.7	6.7	71.4	1.97

Management percentages are mean crop-area shares receiving each practice. Management intensity is the sum of fertilizer, improved-seed, manure and repeated-weeding area shares (range 0-4). IQR: interquartile range.

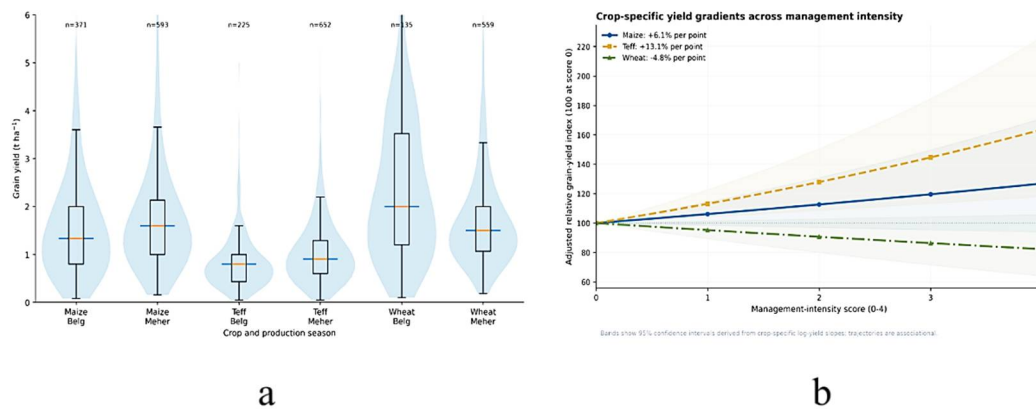


Fig. 1. (a) Grain-yield distributions of maize, teff and wheat across Belg and Meher production seasons in the primary analytical sample. Violin envelopes show the distribution and embedded boxes show the interquartile range and median; the displayed range is 0-6 t/ha for legibility. (b) Crop-specific adjusted relative-yield gradients across the 0-4 management-intensity score. Lines are normalized to an index of 100 at score 0; shaded bands show 95% confidence intervals derived from crop-specific log-yield slopes. The gradients are adjusted associations, not causal treatment effects.

After adjustment for crop, season, region, video attendance and development-agent information agreement, the proportion of crop area receiving chemical fertilizer was associated with 33.0% higher grain yield when comparing zero with complete fertilizer coverage (95% CI 18.3-49.6%; $p < 0.001$; Table 2). Improved-seed area share (0.4%; $p = 0.926$), manure area share (-1.5%; $p = 0.807$) and repeated-weeding area share (-2.2%; $p = 0.574$) were not independently associated with pooled yield. The management-intensity score nevertheless showed a positive pooled association: each one-point increase corresponded to 6.3% higher adjusted yield (95% CI 1.4-11.4%; $p = 0.010$). The fertilizer result is agronomically plausible given widespread nutrient constraints in Ethiopian cereal systems, but it should not be read as the biological effect of a standardized fertilizer dose because the survey records farmers' management rather than randomized nutrient treatments. Controlled and field-based studies similarly show that yield gains depend on rate, timing, soil type and combinations of organic and inorganic inputs (Abebe *et al.* 2022, Mosisa *et al.* 2022, Adem *et al.* 2023, Dimkpa *et al.* 2023, Loha *et al.* 2023, Tufa 2023).

The management-intensity association differed significantly across crops (joint management-intensity $\times$ crop Wald chi-square = 42.55, $df = 2$, $p < 0.001$). It was positive for teff (13.1% per one-point increase; 95% CI 4.3-22.7%; $p = 0.003$), but not for maize (6.1%; -1.5 to 14.4%; $p = 0.119$) or wheat (-4.8%; -10.5 to 1.4%; $p = 0.127$). The corresponding crop-specific relative-yield gradients across the 0-4 management-intensity range are shown in Fig. 1b. Exploratory crop-specific practice models suggested that fertilizer coverage was associated with 17.1% higher

maize yield ($p = 0.013$) and 40.6% higher teff yield ($p = 0.008$), while improved-seed coverage was associated with 29.9% higher teff yield ($p < 0.001$). After Benjamini-Hochberg correction across 12 crop-practice comparisons, the teff fertilizer ($q = 0.047$) and improved-seed ($q = 0.005$) associations remained statistically supported; the remaining crop-specific estimates should be interpreted as exploratory signals (Fig. 2a). The pooled fertilizer and management-intensity results were essentially unchanged after crop-specific 1st-99th percentile yield winsorization (32.5%, $p < 0.001$ and 6.2%, $p = 0.008$, respectively). Teff responses to N and P are known to vary with landscape and fertility status, and wheat nutrient response can differ sharply across soil types and management settings (Dargie *et al.* 2022, Seifu *et al.* 2022, Gedamu *et al.* 2023). The absence of a positive wheat intensity coefficient therefore does not imply that improved management is ineffective; rather, the survey-based score cannot capture nutrient rate, application timing, variety suitability, rainfall or soil constraints that determine agronomic response.

Table 2. Adjusted associations of field management, video attendance and information agreement with grain yield.

Model / predictor	Adjusted difference (%)	95% CI	p	n
Chemical fertilizer area share	33.0	18.3 to 49.6	<0.001	2,535
Improved-seed area share	0.4	-7.5 to 8.9	0.926	2,535
Animal-manure area share	-1.5	-13.0 to 11.5	0.807	2,535
Repeated-weeding area share	-2.2	-9.5 to 5.7	0.574	2,535
Any video attendance	0.8	-6.8 to 9.0	0.842	2,535
DA-information agreement (per point)	4.7	0.2 to 9.3	0.039	2,535
Pooled management intensity	6.3	1.4 to 11.4	0.010	2,535
Maize management intensity	6.1	-1.5 to 14.4	0.119	964
Teff management intensity	13.1	4.3 to 22.7	0.003	877
Wheat management intensity	-4.8	-10.5 to 1.4	0.127	694

Percentage differences are $100[\exp(\beta)-1]$ from log-yield models with kebele-clustered standard errors. Individual-practice models adjust for crop, season, region, video attendance and development-agent information agreement. Management-intensity models use the same covariates; crop-specific models omit crop. Crop-specific coefficients are exploratory.

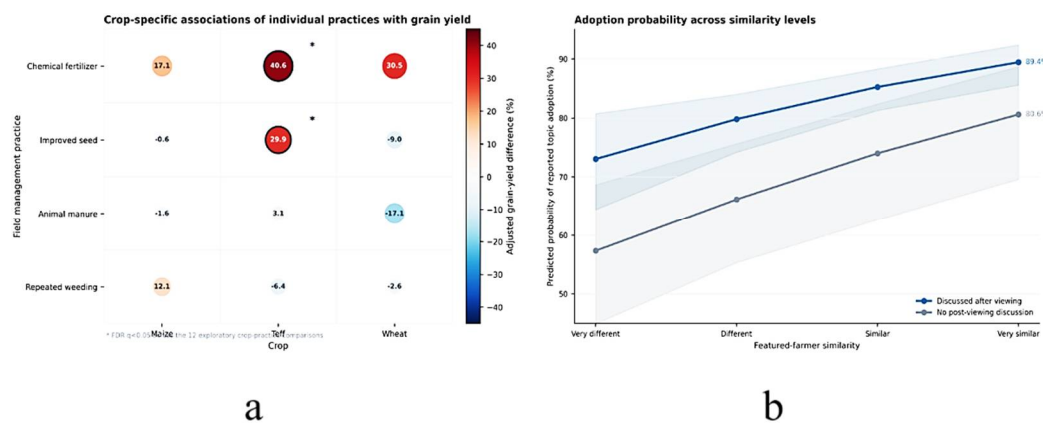


Fig. 2. (a) Bubble matrix of crop-specific associations between individual field-management practices and grain yield. Bubble colour and labels indicate adjusted percentage differences, bubble area reflects absolute effect size, and asterisks denote Benjamini-Hochberg FDR $q < 0.05$ across the 12 exploratory crop-practice comparisons. (b) Marginal predicted probabilities of reported crop-management topic adoption by featured-farmer similarity and

post-viewing discussion. Shaded bands represent 95% confidence intervals from the binomial model, averaged over the observed topic and development-agent agreement distributions among attended topics.

Among the 961 household heads who reported attending at least one programme video, topic exposure was uneven (Table 3). Seeding or planting reached 72.6% of video attendees, followed by fertilizer (64.9%) and land preparation (64.7%); weeding reached 34.0%, while pest control and storage each reached about 13%. Once a topic was attended, discussion was consistently high (90.5-93.8%), whereas reported adoption ranged from 60.0% for pest control to 85.9% for land preparation. In the adjusted topic-level model based on 2,507 attended records, discussion was associated with 2.08 times the odds of reported adoption (95% CI 1.25-3.48; $p = 0.005$), and each one-point increase in similarity to the featured farmer was associated with 1.48 times the odds (1.22-1.80; $p < 0.001$). Development-agent information agreement was not independently associated with topic adoption (OR 0.82; 0.56-1.20; $p = 0.307$). Model-based marginal predictions showed higher adoption probability after discussion across all similarity levels and a monotonic increase with greater featured-farmer similarity (Fig. 2b). These patterns accord with evidence that digital advice works through more than exposure alone: interaction, locally recognizable examples and opportunities to interpret recommendations can influence technology uptake (Abate *et al.* 2023, Abiri *et al.* 2023, Baul *et al.* 2024, Waje *et al.* 2024, Friedson-Ridenour *et al.* 2025, Beach *et al.* 2025).

Table 3. Video-topic attendance, discussion, reported adoption and adjusted adoption associations.

Panel A. Crop-management video topics

Management topic	Attendance, n (%)	Discussion, n (%)	Adoption, n (%)
Seeding/planting	698 (72.6)	651 (93.3)	596 (85.4)
Fertilizer	624 (64.9)	574 (92.0)	468 (75.0)
Land preparation	622 (64.7)	576 (92.6)	534 (85.9)
Weeding	327 (34.0)	296 (90.5)	243 (74.3)
Pest control	130 (13.5)	118 (90.8)	78 (60.0)
Storage	128 (13.3)	120 (93.8)	84 (65.6)

Panel B. Binomial model of topic-level reported adoption

Predictor	OR	95% CI	p	n
Topic discussed	2.08	1.25 to 3.48	0.005	2,507
Featured-farmer similarity (per point)	1.48	1.22 to 1.80	<0.001	2,507
DA-information agreement (per point)	0.82	0.56 to 1.20	0.307	2,507

Attendance percentages use all 961 respondents who attended any video as the denominator; discussion and adoption percentages use topic attendees. Panel B includes 2,507 attended topic records, adjusts for management topic, and clusters standard errors by kebele. Similarity is coded 1 = very different to 4 = very similar; DA agreement is coded 1 = not at all to 4 = high.

Any video attendance itself was not independently associated with pooled grain yield after actual management practices and other covariates were included (0.8%; 95% CI-6.8 to 9.0%; $p = 0.842$). This result reinforces the distinction between information exposure and agronomic implementation. Digital extension can facilitate access and learning, but grain production remains downstream of field management, soil fertility, weather, input quality and timing (Abate *et al.* 2023, Getahun *et al.* 2024, Beach *et al.* 2025). Development-agent information agreement retained a modest positive association with yield (4.7% per one-point increase; 0.2-9.3%; $p = 0.039$), but this single-item perception may also proxy extension contact, farmer experience or unmeasured production advantages and should not be interpreted as a causal credibility effect.

The study has important limitations. The analysis is based on a single public endline round, and intervention assignment was absent from the released files; therefore, video attendance, engagement and credibility-related perceptions were self-selected and cannot identify programme effects. Yield and management were farmer reported, and household-crop-season harvest quantities could only be linked unambiguously to sole-crop fields; multi-crop fields were therefore excluded. The main models identify whether an area received a practice but do not capture fertilizer formulation, exact dose and timing, seed genotype, weed pressure, rainfall, soil properties or management quality. Despite these constraints, linking field-level management with crop-specific harvest data adds an agronomic dimension that is not provided by topic-level adoption alone. The combined evidence indicates that actual management, particularly fertilizer coverage and broader management intensity, was more closely associated with grain yield than video attendance itself, while discussion and relatable featured farmers were associated with reported adoption. For extension programmes, the practical implication is to couple facilitated, locally interpretable communication with crop- and site-specific management recommendations rather than treating information exposure as a sufficient route to productivity gains.

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