

# Stage-Contingent Information Efficacy: Disaggregating the Impact of Advisory Channels on Cocoa Management Practices in Southwest Nigeria

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This study addresses the critical knowledge dissemination gap impeding sustainable cocoa production in Southwest Nigeria, where yields have declined by over 70% since the 1970s despite the availability of improved cultural management practices (ICMP). Using a mixed-methods approach (survey of 283 farmers, focused group discussion and Tobit regression), we investigated the stage-contingent efficacy of information sources on ICMP adoption across four production stages: nursery, on-farm, harvesting, and post-harvest. Results reveal farmer-led channels (Farmer Field Schools: 95.8%; Associations: 92.5%) dominate knowledge access, while institutional sources (CRIN, government agencies) are critically underutilised (< 5%). Adoption rates varied significantly by stage: nursery (38.3%), on-farm (73.8%), harvesting (77.4%), and post-harvest (88.1%). Tobit regression confirmed extension agents significantly increased nursery ( $\beta = 0.18, p < 0.01$ ) and on-farm adoption ( $\beta = 0.05, p < 0.01$ ), but paradoxically reduced harvesting adoption ( $\beta = -0.012, p < 0.10$ ) due to contextual misfit (e.g., unaffordable tool recommendations). Tertiary education amplified adoption across stages (nursery:  $\beta = 0.30$ ; post-harvest:  $\beta = 0.06$ ), while institutional sources negatively impacted harvesting. Post-harvest practices relied solely on experiential learning ( $\beta = 0.001/\text{year}, p < 0.01$ ), with no information-source effects. We propose a stage-targeted Agricultural Knowledge and Information System (AKIS) framework: farmer-led channels for nurseries, co-designed tools for harvesting, and digitised indigenous knowledge for post-harvest. Policy must prioritise context-adapted dissemination to reclaim Nigeria's cocoa sector.

**Keywords:** cocoa production, ICMP, stage-specific adoption, AKIS, information source

## 1 Introduction

Cocoa constitutes a vital pillar of the global agro-economy, sustaining 40–50 million livelihoods and generating over US\$50 billion in annual revenue (Tsowou & Gayi, 2019; Gavrilova, 2021). Its cultivation, predominantly in tropical West Africa, has shaped local economies and social structures since the early twentieth century, accounting for roughly 70% of upstream production and marketing (Kongor et al., 2024). Nigeria's cocoa industry, once responsible for over one-fifth of global output, now contributes barely 6% (Etaware, 2022). Declining productivity reflects ageing orchards, chronic soil fertility deficits, and complete dependence

on chemical pesticides (Aikpokpodion & Adeogun, 2011; Etaware, 2022).

Improved cultural management practices (ICMPs) – including systematic pruning, canopy regulation, phytosanitation, and optimised fermentation – have demonstrated yield increases of 30–40% under both experimental and on-farm conditions (Amusan et al., 2005; Suh et al., 2020). However, only about 25% of Nigerian smallholders routinely apply these practices (Lawal & Oluyole, 2008). This gap highlights critical shortcomings within Nigeria's Agricultural Knowledge and Information System (AKIS), which is marked by weak linkages among research institutes, extension services,

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and farmers, underfunded outreach, and predominantly one-way communication (Agbontale & Issa, 2017; Adetimehin et al., 2018).

Farmers often rely on informal sources – friends, relatives, radio broadcasts – while formal channels, notably the Cocoa Research Institute of Nigeria (CRIN), reach fewer than 5% of producers (Ebewore & Emuh, 2013; Adetimehin et al., 2018). Moreover, advisory content frequently fails to align with on-farm realities; recommendations for specialised tools or high-cost inputs are dismissed as impractical (Baah & Anchirinah, 2010; Awodumila et al., 2022). Recent surveys in Nigeria have linked adoption to socioeconomic factors – age, education, credit access, and cooperative membership – with improved varieties achieving 84.6% uptake compared to 53.0% for integrated pest management (Ilesanmi & Afolabi, 2020; Adebayo et al., 2022). However, these analyses aggregate across the production cycle, obscuring stage-specific dynamics. Nursery practices require demonstration and follow-up; on-farm management hinges on continuing extension support; harvesting depends on labour and tool considerations; and post-harvest processing demands precise timing and microbial control (Dormon et al., 2007; Subroto et al., 2023).

This study adopts a stage-contingent framework, drawing on networked models of agricultural innovation (Kania & Žmija, 2016; Elhadi & Boland, 2016; Albornoz, 2024). It examines whether institutional, extension, media, and NGO information sources exert differential effects on ICMP adoption at the nursery, on-farm, harvesting, and post-harvest stages in Southwest Nigeria.

## 2 Material and Methods

### 2.1 Study Area and Population

This research was conducted in Nigeria's two highest cocoa-producing states: Ondo and Osun. Within Ondo State, we selected Idanre and Ondo-East local government areas (LGAs), and within Osun State, Ife-South and Ife-East LGAs. Our target population comprised smallholder cocoa farmers registered with the Cocoa Growers Association of Nigeria (COGAN), each cultivating approximately 3–4 hectares. These areas were chosen for their representative production profiles and the active presence of COGAN, ensuring that respondents were both typical producers and organised within established farmer networks.

### 2.2 Sampling Strategy

To achieve a representative sample, we employed a four-stage stratified design. First, we purposively selected Ondo and Osun states based on their aggregate cocoa output. Second, we identified the two LGAs with

the highest production volumes within each state. Third, we randomly chose three communities with high COGAN membership densities in each LGA. Finally, we used systematic sampling within each community – interviewing every second registered COGAN farmer – to reach approximately 50% of eligible members. In total, 283 farmers (143 from Ondo and 140 from Osun) participated, yielding a sample size sufficient to estimate proportions with a 95% confidence level and a 5% margin of error.

### 2.3 Data Collection

Data collection combined quantitative and qualitative methods. Trained enumerators administered a structured questionnaire to each selected farmer, gathering information on demographics, farm characteristics, frequency of access to eleven distinct information sources, and adoption of improved cultural management practices (ICMP) across four production stages. To contextualise and enrich these survey data, we conducted twelve focus group discussions (FGDs) of 10–14 farmers each, and eight key informant interviews (KIs) with agricultural extension officers. The FGDs explored farmers' perceptions of information quality and the applicability of ICMP recommendations, while KIs provided institutional and technical perspectives on advisory delivery.

### 2.4 Variable Definition and Measurement

Our primary outcome, ICMP adoption, was measured separately for nursery, on-farm, harvesting, and post-harvest activities. For each stage, respondents indicated the frequency of three specific practices, scored from 1 (never) to 3 (always). Stage-specific indices were then normalised to a 0–3 scale. Information-source variables captured how often farmers consulted eleven channels – ranging from extension agents and institutional bodies (e.g., CRIN, CDUs) to media (radio/TV) and farmer-led NGOs (Farmer Field Schools, associations) – with responses coded as Always = 2, Sometimes = 1, Never = 0. These channels were aggregated into four composite categories (Institutional, Extension, Media, and NGOs) for analysis. Control variables included age, gender, education level, farm size, years of farming experience, ownership status, and membership in social organisations.

### 2.5 Analytical Approach

We estimated the overall adoption rate per production stage as the average of individual practice adoption rates by production stage. The individual practice adoption rate is the sum of the percentage of farmers who always and occasionally use the ICMP. Also, we estimated four Tobit regression models for each production stage to examine

the effect of information-source categories and farmer characteristics on ICMP uptake. The latent adoption intensity for each stage was modelled as a function of information-source scores and control covariates. All models were fitted by maximum likelihood estimation in Stata 17, using cluster-robust standard errors at the LGA level to account for intra-cluster correlation. Statistical significance thresholds were set at  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ .

### 3 Results and Discussion

As shown in Table 1, Farmer Field Schools (FFS) and Farmers' Associations were the most relied-upon sources, with 95.8% and 92.5% of respondents reporting that they always used these channels. Radio and television programs were always consulted by 40.6% of farmers, while only 20.1% consistently accessed Agricultural Extension Agents. Institutional sources such as the Cocoa Research Institute of Nigeria (CRIN) and Cocoa Development Units (CDUs) regularly reached fewer than 5% of farmers. Qualitative insights from FGD revealed that Farmer Field Schools (facilitated by IITA's Sustainable Tree Crop Program) strengthened associations and information access.

The stage-specific adoption rates of ICMP are illustrated in Figure 1. Adoption levels varied markedly across production stages. Nursery

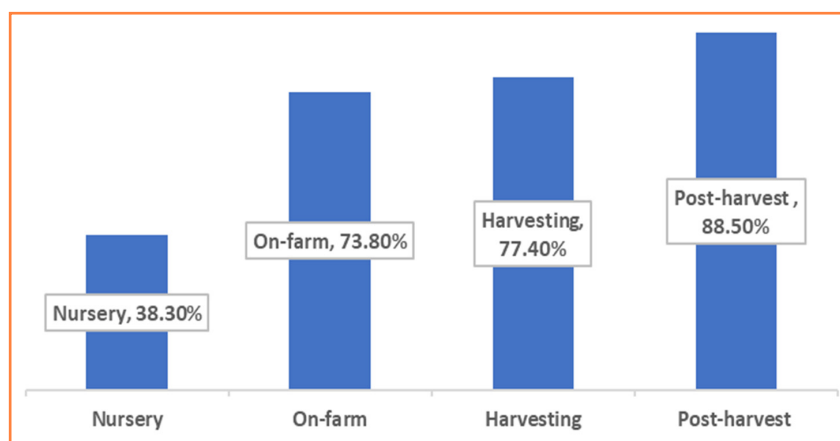


**Figure 1** Adoption Rates of ICMP by Production Stage

operations achieved the lowest uptake (38.3%), followed by on-farm management (73.8%), whereas harvesting and post-harvest practices were adopted by 77.4% and 88.5% of farmers, respectively.

The patterns of ICMP adoption observed in this study reveal a clear need to tailor advisory services to the specific demands of each production stage. Extension agents demonstrated their most significant value in nursery and on-farm settings ( $\beta = 0.18$ ,  $p < 0.01$ ) (Table 2), where regular, hands-on engagement allows them to model practices such as seedling spacing, phytosanitation and selection of a suitable nursery site close to the plantation for shade regulation (Kehinde et al., 2017). However, structural limitations – including high input costs and limited agent coverage – impede widespread adoption. Previous

studies from Ghana and other parts of Nigeria found that farm visits and group demonstrations elevated fertiliser uptake and pruning adoption by up to 4% (Ilesanmi & Afolabi, 2020; Agyei et al., 2023). In contrast, institutional research bodies have struggled to influence harvesting practices ( $\beta = -0.01$ ,  $p < 0.10$ ) (Table 2), even armed with evidence-based recommendations. This might be because their protocols often assume access to specialised tools or labour configurations that smallholders lack, generating the paradoxical effect of reduced uptake when farmers perceive guidance as impractical (Awodumila et al., 2022).

At the same time, the predominance of informal networks – Farmer Field Schools, peer associations, radio broadcasts (Table 1) – presents both opportunity and risk. In Sulawesi,

**Table 1** Access Frequency to ICMP Information Sources (n = 283)

| Source                          | Always (%) | Sometimes (%) | Never (%) | Mean score* |
|---------------------------------|------------|---------------|-----------|-------------|
| Farmers' association            | 92.5       | 7.1           | 0.4       | 1.92        |
| Farmer Field School (FFS)       | 95.8       | 2.8           | 1.4       | 1.94        |
| Radio/TV programs               | 40.6       | 50.2          | 9.2       | 1.31        |
| Agricultural extension agents   | 20.1       | 76.0          | 3.9       | 1.16        |
| License Buying Agents (LBAs)    | 11.0       | 79.2          | 9.8       | 1.01        |
| Cocoa Research Institute (CRIN) | 5.0        | 8.8           | 86.2      | 0.19        |
| Other institutional sources**   | <2.5       | <7.0          | >90.0     | <0.15       |

\*Mean score – (always  $\times$  2 + sometimes  $\times$  1 + never  $\times$  0)/100; \*\* includes Agricultural Input Supply Agency (AISA), Department of Produce Inspection Service (DPIS), National Cocoa Development Committee (NCDC), Cocoa Development Units (CDUs), Agricultural Development Programme (ADP)

**Table 2** Significant Predictors of ICMP Adoption Across Production Stages

| Stage               | Predictor                          | $\beta$ | <i>p</i> -value |
|---------------------|------------------------------------|---------|-----------------|
| <b>Nursery</b>      | extension agents                   | 0.18    | 0.01            |
|                     | tertiary education                 | 0.30    | 0.01            |
|                     | farm ownership                     | 0.09    | 0.01            |
|                     | membership in social organisations | -0.13   | 0.01            |
| <b>On-farm</b>      | extension agents                   | 0.05    | 0.00            |
|                     | secondary education                | 0.04    | 0.05            |
|                     | tertiary education                 | 0.08    | 0.01            |
| <b>Harvesting</b>   | institutional sources              | -0.012  | 0.06            |
|                     | extension agents                   | -0.012  | 0.09            |
| <b>Post-harvest</b> | tertiary education                 | 0.06    | 0.002           |
|                     | farming experience (per year)      | 0.001   | 0.01            |
|                     | farm size (per ha)                 | 0.003   | 0.08            |
|                     | age > 50 years                     | 0.02    | 0.02            |

rapid diffusion of cocoa innovations through farmer networks underscores the power of peer-to-peer exchange (Bahfiarti, 2016). In Southwest Nigeria, these networks ensure near-universal reach for day-to-day agronomic tips, but they can reinforce outdated or suboptimal routines without complementary technical support. Radio, while ubiquitous, typically delivers one-size-fits-all messages that lack the granularity required for labour-intensive stages such as fermentation, where precise timing and microbial management are critical (Subroto et al., 2023).

A powerful factor influencing farmers to adopt ICMP was education, with the study yielding much higher adoption results among farmers with any form of formal education, especially those who had achieved a tertiary education level (Table 3). The contexts where we found most adoption happening were nursery ( $\beta = 0.30$ ), on-farm ( $\beta = 0.08$ ), and post-harvest ( $\beta = 0.06$ ). This implies that education enhanced farmers' capacity to utilise ICMP (Adebayo et al., 2022). To capitalise on this human-capital dividend, extension approaches must evolve beyond top-down instruction toward facilitation of critical reflection and peer learning, potentially leveraging digital platforms or moderated WhatsApp groups to sustain engagement among educated cohorts (Oso et al., 2020).

The most glaring gap lies in post-harvest adoption, where none of the formal or informal channels we measured had a significant effect (Table 2). Since fermentation and drying protocols can substantially affect product characteristics (Albertini et al., 2015), this disconnection represents a critical loss of value. Developing on-demand, context-sensitive learning tools – such as interactive voice response modules in local dialects or cooperative-organised demonstration plots – could deliver timely, stage-specific guidance when farmers need it most.

These insights call for a reconfigured Agricultural Knowledge and Information System in Nigeria. Extension resources should be disproportionately directed toward nursery and on-farm phases, where demonstration yields the highest ROI. At the same time, harvesting protocols must be co-created with farmers to ensure local relevance. Institutional outputs may require translation into vernacular, illustrated guides and field-tested procedures. An "Extension-Education Alliance" could pair educated youth with veteran farmers in hybrid Field School Plus programs, facilitating two-way knowledge flows. Finally, post-harvest training must embrace multimedia channels – radio dramas, mobile audio tutorials, and IVR – to reinforce best practices at the point of harvest. Future research should employ longitudinal methods and social-network analysis to

**Table 3** Education Level as Moderator of ICMP Adoption

| Education Level  | Nursery ( $\beta$ ) | On-farm ( $\beta$ ) | Post-harvest ( $\beta$ ) |
|------------------|---------------------|---------------------|--------------------------|
| <b>Primary</b>   | -0.09               | 0.01                | 0.02*                    |
| <b>Secondary</b> | 0.04                | 0.04*               | 0.01                     |
| <b>Tertiary</b>  | 0.30**              | 0.08***             | 0.06***                  |

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

compare high and low cocoa production areas and quantify the influence of informal social networks on adoption dynamics.

#### 4 Conclusions

This study demonstrates that the effectiveness of advisory and information channels in driving the adoption of improved cultural management practices (ICMPs) varies sharply across the cocoa production cycle. Adoption was lowest at the nursery stage (38.3%), where extension services exerted a significant positive influence ( $\beta = 0.18$ ,  $p < 0.01$ ), without fully offsetting structural constraints such as input costs and inadequate nursery infrastructure. On-farm adoption was comparatively higher (73.8%) and remained positively associated with extension contact ( $\beta = 0.05$ ,  $p < 0.01$ ), reflecting the suitability of demonstrations and routine farm visits for practices such as pruning, weeding, and phytosanitation.

By contrast, harvesting practices, with relatively high adoption levels (77.4%), were negatively associated with both extension advice and institutional information sources ( $\beta = -0.012$ ,  $p < 0.10$ ). This finding highlights a persistent contextual misfit between prescriptive recommendations and farmers' socioeconomic realities, particularly regarding labour availability and access to specialised tools. At the post-harvest stage, adoption was highest (88.1%), with none of the formal information channels showing a significant effect. However, experiential learning emerged as the dominant driver, with each additional year of farming experience increasing adoption ( $\beta = 0.001$ ,  $p < 0.01$ ), confirming the centrality of indigenous knowledge in ICMPs.

Across all stages, education consistently amplified adoption outcomes. Tertiary education exerted the strongest effect in the nursery ( $\beta = 0.30$ ), with additional positive effects on on-farm ( $\beta = 0.08$ ) and post-harvest ( $\beta = 0.06$ ) practices, highlighting the role of human capital in interpreting, adapting, and integrating diverse knowledge sources.

These results indicate that Nigeria's Agricultural Knowledge and Information System requires fundamental reorientation. Rather than uniform dissemination, advisory services should be precision-tailored to production stages: intensifying extension support at nursery and on-farm levels, co-designing harvesting tools and protocols with farmers to ensure affordability and relevance, and recognising post-harvest knowledge as largely experiential while selectively enhancing it through context-sensitive learning tools. Embedding formal education, peer networks, and stage-appropriate multimedia within this redesigned AKIS offers the most viable pathway for closing yield and quality gaps,

strengthening farmer livelihoods, and restoring Nigeria's competitiveness in the global cocoa economy.

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