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Agricultural extension effectiveness in Ghana and Sub-Saharan Africa: A systematic review of outcomes, methods, and institutional models

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Abstract

In Ghana and the rest of Sub-Saharan Africa, agricultural transformation still heavily relies on agricultural extension, which is still subject to a great deal of controversy. This is a systematic review of the available empirical evidence on the effectiveness of agricultural extension, with a particular focus on the outcomes achieved, the approaches used to measure effectiveness, and institutional models of service delivery. The review relies on PRISMA reporting standards and discusses the studies published in peer-reviewed journals between 2000 and 2024 placing the experience of Ghana within the context of the evidence base of Sub-Saharan Africa. The review demonstrates that agricultural extension has a consistent positive effect on the level of knowledge, awareness, and adoption of better technologies, including soil management, better inputs, and climate-smart agricultural practices by the farmers. Nonetheless, economic effects on productivity, agricultural revenues, food security, and resiliency tend to be rather small, disproportionate, and highly situational. The literature uses observational and quasi-experimental design dominantly, but emerging but still scarce applications of randomized controlled trials and mixed-methods approaches dominate the methodology. The limitation of comparability across studies and a weakened policy finding are caused by short evaluation horizons, differences in outcome indicators, and insufficient focus on the social and institutional aspects. There is no single extension model, be it public, private, NGO-led or farmer-based that has been able to outperform the others institutionally. Instead of that, effectiveness hinges on the coordination, resourcing, and connection of extension services to complementary inputs and markets and facilitated policies. Such cross-cutting issues like gender and youth inclusion, digitalization, capacity constraints, and financing environments have a substantial impact on the results of extensions and are not fully investigated in most research studies. The experience of extension in Ghana is a reference to the larger trends of pluralism, innovation and unrelenting capacity issues in the region. It is concluded in the review that extension should be enhanced through hybrid systems, inclusion of policy design, long-term funding, and evaluation systems that are able to capture both long-term and multidimensional developmental results.

Keywords: Agricultural extension, Sub-Saharan Africa, Ghana, Institutional, Models

Introduction

The African researchers have always recognized extension as one of the main factors in technology spread and enhanced performance of farms, especially in the case of smallholder producers who are extensively dependent on outside information and consultations (Benin *et al.*, 2012; Davis *et al.*, 2012) ^[4, 8]. In Sub-Saharan Africa, there is empirical evidence indicating that the overall access to extension services sees higher uptake of improved seeds, fertilizer, soil management and climate-smart practices but the effects on yields, income and welfare are generally small and highly heterogeneous across agro-ecological and institutional settings (Ragasa *et al.*, 2013; Abdul-Rahaman and Abdulai, 2018) ^[17, 1]. This noticed heterogeneity has caused the scholarly shift in both questions and methods, whereby the production of meaningful and sustained results by extension is not only how but also who and under which institutional and methodological conditions.

The development of agricultural extension in Ghana has passed through a number of institutional stages, which have reflected general trends in the region. The initial post-independence extension was based on centralized and top-

down advisory rules that were left behind during the colonial regime, and much focus was on the transfer of technology and commodity promotion. Since the later 1980s, such reforms were directed on enhancing efficiency, accountability and responsiveness to farmers, and leading to the unification of the extension service by the Ministry of Food and Agriculture and the creation of the Directorate of Agricultural Extension Services as the national coordinating body. The implementation of the Ghana Agricultural Extension Policy institutionalised a move towards decentralisation, demand-based service delivery and pluralism with explicit acknowledgment of the complementary value of the NGOs or other private advisory providers and farmer-based organisations to the role of the public sector (MoFA, 2005; Birner *et al.*, 2009) ^[12, 5].

DAES is required to organize extension planning, assist in capacity building of frontline agents, enhance research-extension-farmer connections and harmonise the progressively pluralistic advisory environment. Nonetheless, the empirical evaluation of the extension system in Ghana points out to the continued structural and operational limitations. The high ratio of agent to farmers, poor logistics

and transport, insufficient operational funds and lopsided incentive systems still do not support the level of service intensity and quality at the district level (Benin *et al.*, 2012; Ragasa *et al.*, 2013) ^[4, 17]. Ghanaian studies conducted in the north and middle-belts also indicate that although extension contact brings up adoption probabilities, these limits curtail follow-up, the extent of engagement and long-term behavioural change, and can be used to explain why perceived effects are usually observed to be incremental as opposed to transformative (Abdul-Rahaman and Abdulai, 2018) ^[1].

New policy efforts are indicative of efforts to address these shortcomings. The plan of Agriculture e-Extension Services Strategy (2022-2030) in Ghana facilitates the provision of ICT-based tools of delivering advisory services such as radio, mobile platforms and interactive voice Response Systems to ensure a wider coverage area, to decrease the cost of delivery and supplement face-to-face extension. It is indicated with evidence from Ghana and other African settings that digital extension can enhance access to information and adoption of more advanced practices among farmers, although it has the most significant effects when digital technologies are complemented by human facilitation, trust-building and supportive institutional conditions (Aker, Ghosh, and Burrell, 2016; Ragasa, 2019) ^[2, 16]. Digitalisation then does not solve the old debates on the effectiveness of extensions but rather redefines them by posing new questions regarding the quality of content, equal access and coordination between institutions.

Another source of dispute is related to equity and inclusion. Even though the extension policy in Ghana is clear and explicitly focuses on gender responsiveness, African studies are always ready to report that women farmers have structural, socio-cultural and institutional challenges that act as barriers to accessing advisory services, inputs and markets. These are time pressures, sexual roles, all-male extensions staffing and lack of control over the productive resources (Ragasa *et al.*, 2013; Doss *et al.*, 2018) ^[17, 9]. These inequalities have given concerns that pluralistic and progressively market oriented models of extension can inappropriately favor commercially oriented or male farmers unless a deliberate effort by the public systems to maintain outreach inclusivity.

The case of Ghana explains why we should use systematic evidence synthesis. The effectiveness of the extension is not possible to assess without taking into account institutional design, the way of delivery and evaluation method. Research findings are very diverse in terms of the outcome of the research, rigour of the methodology and time spans and therefore it is hard to derive clearly transferable policy lessons. Synthesising the outcomes of a systematic review, comparing methodological studies and analysing institutional models, with Ghana placed in the broader Sub-Saharan African evidence base, is then necessary to understand which types of extension produce long-term, equitable and cost-effective effects.

Conceptual and theoretical Framework

Conceptualizing agricultural extension effectiveness.

The most understandable definition of agricultural extension effectiveness would be a process through which the

dissemination of knowledge is connected to behavioral change and eventually to the better livelihood outcome among farming households. Instead of considering the success of the extension by contact rates or technology spread, the current African scholarship defines effectiveness as the degree to which advisory services help farmers to make more informed decisions, adopt better practices and realize quantifiable gains in productivity, income, and food security (Birner *et al.*, 2009; Nwafor *et al.*, 2021) ^[5, 14].

The extension effectiveness lies in knowledge transfer as its basis. The extension systems are meant to deliver agronomic knowledge, management skills, climate information and market intelligence to the farmers through the research institutions and service providers. Traditionally in Ghana, public extension under the Ministry of Food and Agriculture has placed its emphasis on the spread of improved varieties of crop, fertilizer recommendations and good agronomic practices as one of the avenues to agricultural modernization (MoFA, 2011) ^[13]. It has been empirically indicated that farmers who are in contact with the extension agents are more in terms of their awareness and knowledge about better technologies, than non-contact farmers (Benin *et al.*, 2012; Davis *et al.*, 2012) ^[4, 8]. The African studies, however, warn that acquisition of knowledge is not the sole solution to evaluating the effectiveness of extension because the information does not necessarily translate into practice when farmers have financial, labor or institutional constraints (Nwafor *et al.*, 2021) ^[14].

Behavior change is the key mediating variable between transfer of knowledge and welfare. It is the incorporation, adoption and continued utilization of the recommended practices by farmers. Ghanaian studies show that access to extensions has a strong impact on the likelihood of adopting soil conservation practices, climate-smart agriculture, and better use of inputs, however, the intensity of the adoption depends on the characteristics of households, gender, education, and access to complementary resources (Danso-Abbeam *et al.*, 2022; Abdul-Rahaman and Abdulai, 2018) ^[7, 1]. The digital extension efforts in Ghana are another indication that information can be used to induce behavior change through advisory services based on ICT when this information is timely, locally relevant, and human facilitated (Aker *et al.*, 2016; Jones *et al.*, 2024) ^[2, 20]. The findings support the opinion that the effectiveness of extensions should be measured based on the actual change in practice as opposed to the exposure to information.

The final dimension of the extension effectiveness is the livelihood outcomes. Such consequences are improved crop output, agricultural revenues, food security in households, food diversity and shock resistance. Recent studies using nationally representative panel data on Ghana reveal access to extension services to be positively correlated with growth in household assets, food consumption and dietary diversity, with especially large-scale effects observed when extension is implemented using farmer-based organisations (Aremu *et al.*, 2025) ^[22]. However, in reviews of African countries, the impacts of livelihood are typically small and imbalanced due in part to evaluations of short-term impacts, and not taking into consideration the aggregate effect of a sustained change in behavior (Ragasa *et al.*, 2013; Nwafor *et al.*, 2021) ^[17, 14].

Theoretical perspectives

This review uses three complementary theoretical approaches to describe the ways and reasons that agricultural extension interventions produce different effects in different contexts: Diffusion of Innovations, Agricultural Innovation Systems, and pluralistic and participatory extension theories. Combined, these views transcend the linear approaches to technology transfer and offer a more detailed foundation on the interpretation of extension performance in Ghana and Sub-Saharan Africa.

Diffusion of Innovations

The Diffusion of Innovations theory offers one of the oldest and most powerful models of the distribution of new ideas and technologies within the social structures. As Rogers (2003) ^[18] employs, the perceived attributes of innovations (relative advantage, compatibility, complexity, trialability and observability), communication channels, time and social structure shape the adoption. This theory applies to the agricultural extension system by putting the extension agents at the center of change agents, who impact the awareness of farmers, the persuasion and adoption decisions.

African extension research has extensively used the diffusion theory in attempting to rationalize the disproportionate use of improved seeds, fertilizer, soil conservation and climate-conscious practices. It has been shown that the decision of farmers to adopt is highly determined by peer networks, trust in the extension agents and perceived risk, and not necessarily information exposure (Abdul-Rahaman and Abdulai, 2018; Danso-Abbeam *et al.*, 2022) ^[1, 7]. Nevertheless, opponents believe that diffusion theory is excessively focused on individual decision-making and it underestimates structural factors, including access to credit, land tenure insecurity and gender norms, which are especially relevant in African smallholder systems (Doss *et al.*, 2018) ^[9]. Consequently, the diffusion theory is best applicable when it is used together with frameworks that explicitly take into consideration institutional and systemic influences.

Agricultural Innovation Systems

The Agricultural Innovation Systems (AIS) viewpoint broadens the analytical framework that could focus on an individual adopter to a wider group of actors, institutions and interactions that could produce, distribute and utilize agricultural knowledge. The AIS models innovation as a process that takes place through a group and repetitive process where farmers, extension services, research institutions, markets, policymakers and private actors are involved (World Bank, 2012; Klerkx *et al.*, 2012) ^[19, 1].

AIS has gained more and more prominence in extension research in Sub-Saharan Africa owing to its capacity to embrace the multidimensionality of the pluralistic concerns of advisory settings. According to research in Ghana, the effectiveness of extensions is highly influenced by the quality of linkages between research institutions, DAES, NGOs and farmer-based organizations, as opposed to the impact of extension contact (Birner *et al.*, 2009; Ragasa, 2019) ^[5, 16]. Lack of coordination, divided funding and incentives in the innovation system characteristically restrain the transfer of knowledge into living results. The

AIS framework thus offers a sound theoretical foundation in measuring the institutional models and the reason as to why the same approach of extension results in varied results in different settings.

Pluralistic and participative extension structures

Pluralistic and participatory extension models focus on the decentralization, the diversity of stakeholders and involvement of farmers in the production and dispersion of knowledge. The methods developed as a reaction to the inefficiency of the top-down system of public extensions and are based on the theory of participatory development in which farmers are perceived as co-creators of knowledge, not as the recipient (Chambers, 1994; Davis *et al.*, 2012) ^[6, 8].

Pluralistic extension systems in Ghana and in Sub-Saharan Africa are now characterized by simultaneous participation of public agencies, NGOs, and digital service providers and farmer organizations in providing services. Empirical results indicate that participatory models like Farmer Field Schools and farmer-led advisory models contribute to a better learning process, more trust and behavior change, especially in the context of social learning and experimentation being the focal points (Davis *et al.*, 2012; Ragasa *et al.*, 2013) ^[8, 17]. Nevertheless, as African scholars have warned, pluralism will also result in the occurrence of coordination failures, unequal quality and marginalization of poorer or women farmers unless robust public accountability and inclusion policies are ensured (Ragasa, 2019; Doss *et al.*, 2018) ^[16, 9]. Diffusion of Innovations describes micro-level adoption, Agricultural Innovation Systems reflects meso-level institutional relationships and pluralistic and participatory frameworks elucidate the governance and inclusion and power relationships. By combining these two point of views, the review will be able to critically evaluate the question of whether, and how, institutional arrangements, models of delivery and methodological decisions influence the effectiveness of extension in Ghana and Sub-Saharan Africa.

Extension input to outcome pathways

Agricultural extension affects the performance of farmers in a complex network of relationships in which inputs of the extension to knowledge acquisition, behavior change, and finally livelihood outcomes are connected. These pathways are influenced by the institutional settings, rather than working as a linear communication of information; they are influenced by the characteristics of farmers, enabling or restraining contextual factors. These pathways are necessary in the interpretation of reasons behind the observed variable effects of extension interventions in Ghana and Sub-Saharan Africa.

The former route works using the input of extensions which are the frequency and quality of advisory contact, competencies of the extension agents, the relevance of the technical content, and the modality of delivery adopted (face-to-face, group-based, ICT-enabled, or blended). The evidences in Africa reveal that the intensity of the extension and the training levels of the agents correlate with the learning outcomes, especially where the advice is offered according to the local agro-ecological conditions (Benin *et al.*, 2012; Birner *et al.*, 2009) ^[4, 5]. In Ghana, the resource

limits like high agent-to-farmer ratios and inadequate logistics minimize the efficacy of the extension inputs, undermining this first connection in the route (Ragasa *et al.*, 2013) ^[17].

Knowledge and learning mechanisms are extension input outputs. These are creation of awareness, ability development, problem solving capability and social learning. Research in Africa shows that extension services have been shown to increase farmers knowledge on better seeds, fertilizer use, soil conservation and use of climate-sensitive practices (Davis *et al.*, 2012; Nwafor *et al.*, 2021) ^[8, 14]. Nevertheless, education of the farmers mediates learning, previous experience and trust to the extension providers. Experiential learning and peer validation have been demonstrated to be reinforced through the participatory approaches and farmer-to-farmer learning (Chambers, 1994; Davis *et al.*, 2012) ^[6, 8].

The second pathway is the behavioral change specifically the adoption, adaptation, and permanent practice of the recommended practices. The Ghanaian research indicates that the extension contact enhances the likelihood of the adoption of improved technologies, yet the intensity and persistence of adoption are contingent on the availability of the complementary resources including credit, labor, land security and markets (Abdul-Rahaman and Abdulai, 2018; Danso-Abbeam *et al.*, 2022) ^[1, 7]. This is an important bottleneck stage: the farmers might have sufficient knowledge but fail to change behavior because of risk aversion, gender norms or institutional constraints. Subsequently, the concept of extension effectiveness is evaluated more and more at the level of actual practice change not only at the level of knowledge exposure.

Livelihood outcomes such as productivity, income growth, food security, resilience and even empowerment receive behavioral change. Facts on Ghana suggest that access to extensions is positively related to farm productivity and household welfare indicators, including food consumption and asset accumulation though the effects tend to be small and unevenly distributed among farmer populations (Benin *et al.*, 2012; Ragasa *et al.*, 2013) ^[4, 17]. African reviews highlight the fact that livelihood outcomes generally appear over longer terms than those of most of the evaluation, which accounts for underestimating the impacts of extension in studies in the short term (Nwafor *et al.*, 2021) ^[14].

Notably, these pathways are regulated by institutional and contextual factors. Pluralistic systems of extensions like the ones that are at work in Ghana are characterized by the inclusion of public agencies, NGOs, private providers and digital platforms with dissimilar incentives and target audiences. The lack of coordination, unequal quality control and marginalization of women or poorer farmers has the potential to destroy pathways between inputs and outcomes (Ragasa, 2019; Doss *et al.*, 2018) ^[16, 9]. On the other hand, as the extension inputs are well coordinated, inclusive, and connected to markets as well as input supply systems, the knowledge-wise to livelihoods pathways are reinforced.

Methodology

This paper has used a systematic review design to forge empirical evidence on the efficacy of agricultural extension in Ghana and Sub-Saharan Africa. The strategy was undertaken to bring together disjointed cross-country, cross-

extension, cross-model, and cross-methodological traditions of research and findings and to present a consistent body of evidence applicable to African agricultural research and policy.

The review was conducted in accordance with the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA), thereby providing a clear identification, screening, and synthesis of appropriate studies (Page *et al.*, 2021) ^[21]. Due to the variability of the interventions of the extension, outcome measures and the research designs used in the African context, the narrative and thematic synthesis approach was used instead of statistical meta-analysis.

Scopus, Web of Science, ScienceDirect, AGRIS, CAB Abstracts and Google Scholar were used in an extensive literature search. The reason behind the choice of these databases was that they would help to capture interdisciplinary research covering the fields of agricultural science, extension education, rural development, and innovation research. The keywords were search terms that combined keywords indicating agricultural extension, advisory service, technology adoption, productivity, livelihood outcome, Ghana and Sub-Saharan Africa with Boolean operators and truncation used accordingly. The reference lists of the most important review articles and most used empirical studies were also filtered.

The searches used articles developed in 2000-2024, which represented the time span of significant extension reforms, the emergence of pluralistic delivery models, and the growth of digital advisory services in Africa. Only publications in English were considered.

Developable articles were those that were empirical and concerned Ghana or other nations in Sub-Saharan Africa. Only the quantitative, qualitative, and mixed-methods were considered where they investigated the relationship between the agricultural extension or advisory services and the farm-level outcomes. Investigations were to report the findings in terms of knowledge gain, technology or practice uptake, productivity, income, food security, stability, or empowerment. Opinion papers, abstract articles, and research not specifically related to extension services and outcomes were eliminated. The study selection was done in stages, such as title and abstract screening and complete-text selection. The process of screening was performed without any coercion, and the disagreements were managed through a discussion. The PRISMA flow diagram was used to record the selection process.

A standardised template was used to extract the data in terms of the study location, agro-ecological context, research design, the delivery model of the outcome measures, and the key findings. With methodological heterogeneity, synthesis of evidence was done in a narrative and thematic manner, categorising all the studies by outcome category, extension model, and institutional arrangement. The quality of studies and the risk of bias were determined by design-appropriate criteria and informed interpretation of findings instead of acting as thresholds to rule out studies.

Characteristics of reviewed studies

Knowing the attributes of the literature is a precondition in any systematic review, as the spread of studies, both geographically and over time, through methods and to the

target population, predetermines what we can know about the effectiveness of extension services. Research on agricultural extension in Ghana and Sub-Saharan Africa exhibits different patterns in geographic coverage, time focus, research designs, and the populations and farming systems under investigation. These patterns can be described to understand where evidence is thick, where it is thin, and how methodological decisions are used to make inferences.

Geographic coverage of studies: Ghana and Sub-Saharan Africa

The distribution of evidence-based information is not even across the region. Multi-country reviews and frameworks indicate that policy and research focus on extension has been most valuable in countries with high levels of donor programs, active research facilities, and more well-developed data infrastructure systems (Birner *et al.*, 2009)^[5]. The literature on Ghana is relatively well-covered due to the long-term government initiatives, donor-funded initiatives, and scholarly research that have correlated the extension inputs with household and plot-level results (Benin, 2016). The macro and micro views of extension returns on the economy-wide basis of public spending, as provided by nationally representative analyses and studies in Ghana, show that these approaches are less frequently used in lower-capacity countries (Benin, 2016; Benin *et al.*, 2012)^[6, 4]. On the regional level, the recent literature reviews reflect increasing but uneven distribution of the studies in Sub-Saharan Africa, with the powerful clusters in East Africa (Kenya, Ethiopia, Tanzania) and West Africa (Ghana, Nigeria, Cote d'Ivoire) and less dense coverage in Central Africa (Nwafor, Ogundej, and Nwafor, 2021; Birner *et al.*, 2009)^[14, 5]. This spatial bias is important: the syntheses of regions are often based on a relatively small number of country contexts to make general conclusions, which decreases the validity of the extrapolation between highly heterogeneous agro-ecological and institutional landscapes.

Temporal changes in extension research

There are two general trends in time. First, the last fifteen years have seen increased interest in pluralistic models and institutional analysis, as seen in both conceptual work and country studies that discuss the interaction among providers in the public, private, and NGO sectors (Birner *et al.*, 2009)^[5]. Second, there has been an increase in research on ICT- and digitally enabled advisory services and their capacity to scale up extension to a higher level over the last decade (Aker, Ghosh, and Burrell, 2016)^[2]. Coupled with these topical changes, there has been an evolving methodological landscape, with more rigorous techniques of impact evaluation, such as randomized controlled trials and quasi-experimental approaches, becoming predominant development research in the 2000s and 2010s, and scholars using experimental designs and more powerful methods of identification testing of extension interventions (Duflo, Glennerster, and Kremer, 2007)^[10]. The literature reviews of the African extension point out that interest in mixed-methods and participatory evaluations persists, but the growing number of experimental and quasi-experimental studies have enhanced causal inference and also

demonstrated impacts heterogeneity in contexts (Nwafor *et al.*, 2021; Ragasa, 2014)^[14, 15].

Designs and sources of data

The literature reviewed includes the experimental, quasi-experimental, observational, and qualitative designs. Discrete interventions (such as digital messaging, subsidy packages or specific training) have been experimentally evaluated (RCTs) and randomly rolled out, which provides high internal validity when done (Duflo *et al.*, 2007)^[10]. Quasi-experimental designs include difference-in-differences, propensity score matching and instrumental variables and are frequently applied where randomization is not possible, and are frequently utilized in national or subnational studies of the effects of extensions (Benin *et al.*, 2012)^[4]. These studies remain numerous and offer breadth, particularly in inferring patterns across geographic areas and household forms, but are also susceptible to selection bias (Ragasa *et al.*, 2013)^[17]. Participatory appraisals (such as those in Farmer Field School evaluations) and qualitative case studies (to supplement the quantitative) are used to shed light on mechanisms, social norms, and institutional processes that support adoption and continued practice change (Davis *et al.*, 2012)^[8]. According to the reviews, such an advantage as the richness of the data sources, including national panels and household surveys, administrative records, and project monitoring data, is evident, but heterogeneity in the indicators and time horizons makes synthesis difficult (Birner *et al.*, 2009; Nwafor *et al.*, 2021)^[5, 14].

Farmer populations and agribusiness

Smallholder farmers are often the focus of studies, yet the term "smallholder" is broad and encompasses a variety of production systems, ranging from market-driven cash cropping to subsistence mixed agricultural activities. In Ghana, there has been a focus on staple crops (maize and rice) and cocoa systems and agro-ecological zones (northern savannas versus forest/southern zones) as a result of national interests and data available (Benin *et al.*, 2012; Danso-Abbeam *et al.*, 2022)^[4, 7]. Program objectives also differ when it comes to target populations: some interventions directly target women, youth or farmer organizations and others aim at commercializing producers or lead farmers. It has been noted in reviews that not all studies disaggregate by gender, age, or resource endowment, preventing the determination of the extent of differences in the effects and fairness of extension services (Ragasa, 2014; Doss *et al.*, 2018)^[15, 9]. Finally, the studies of farming systems demonstrate that the adoption pathways and extension effectiveness are extremely dependent on market access, opportunities for off-farm employment, land tenure, and resources, which are not universal and vary depending on the ecological zone and are to be considered central in the interpretation (Birner *et al.*, 2009; Nwafor *et al.*, 2021)^[5, 14].

Extended results of measurement

Agricultural extension has been evaluated using a large set of outcome indicators aligned with the multiple objectives that extension systems are supposed to address. In Ghana and Sub-Saharan Africa, there are studies that analyze the

results at various stages of the extension impact pathway, such as short-term benefits of knowledge gains to long-term livelihood and social benefits. This paragraph synthesizes the key outcome areas identified in the literature and highlights trends and shortcomings in measuring the effects of extension services.

The outcomes of knowledge and awareness

Knowledge and awareness outcomes are the closest and most common outcomes of extension services. These results include knowledge of learning among farmers, availability of information, knowledge of better technologies, and awareness of recommended agronomic practices. Many studies have been conducted in Africa indicating that exposure to extension agents contributes more to the farmer regarding their knowledge about improved seeds, use of fertilizers, pests management and climate-smart activities (Davis *et al.*, 2012; Benin *et al.*, 2012) ^[8, 4]. In Ghana, it has been found that the exposure to extension has been associated with being aware of soil conservation methods and better practices in crop management especially among farmers whose lifestyles are influenced by group-based or participatory extension programs (Danso-Abbeam *et al.*, 2022) ^[7].

Although they are important, knowledge outcomes are increasingly regarded as too few indicators of extension effectiveness on their own. African researchers warn that access to information does not necessarily translate into higher performance in situations where farmers face binding constraints to accessing information, such as a credit crunch, a labour crunch, or uncertain land tenure (Ragasa *et al.*, 2013) ^[17]. Consequently, recent research focuses on the importance of evaluating whether knowledge gain leads to significant behaviour change rather than treating learning outcomes as the final objective.

Behavioural and adoption outcomes

Outcomes in behaviours and adoption measures quantify changes in farmers' practices after exposure to extension, such as acceptance, adaptation, and maintenance use of the recommended technologies. Such consequences are the focus of most empirical assessments, as they reflect the primary process through which extension determines productivity and welfare. Experience in Ghana and other Sub-Saharan African nations consistently demonstrates that extension services increase the likelihood of implementing improved technologies such as high-yielding crop varieties, soil and water conservation methods, and climate-conducive agriculture (Abdul-Rahaman and Abdulai, 2018; Danso-Abbeam *et al.*, 2022) ^[1, 7].

Nevertheless, the literature notes substantial variation in the intensity and persistence of adoption. Research has found that extension leads to higher initial uptake, but longer-lasting practice change will require access to complementary inputs, market incentives, and options for risk management (Ragasa *et al.*, 2013) ^[17]. Female norms and household decision-making patterns also influence adoption, as women farmers tend to adopt less frequently, regardless of their knowledge level (Doss *et al.*, 2018) ^[9]. Such results underscore the importance of interpreting adoption outcomes within their broader socio-economic and institutional contexts.

Productivity and economic results

Among the policy-relevant measurements of the effectiveness of extensions are productivity and economic outcomes. There are variations in crop yields, farm revenues, production efficiency, and market share. Econometric analysis of household- and plot-level data in Ghana demonstrates a positive relationship between extension access and staple crop yields, specifically maize and rice, albeit with most estimates of relatively small magnitude (Benin *et al.*, 2012; Abdul-Rahaman and Abdulai, 2018) ^[4, 1]. The same trends are also documented in Sub-Saharan Africa, where incremental yield gains, rather than transformative productivity changes, are commonly recorded as a result of extension interventions.

Effects on income are less favourable. although some studies indicate that extension has positive effects on farm income and commercialization, other studies report weak or statistically insignificant income effects, which can be attributed to price volatility, input costs, and access to markets (Ragasa *et al.*, 2013; Davis *et al.*, 2012) ^[17, 8]. The result of these contradictory outcomes has led researchers to warn that extension should be assessed not only by short-term productivity or income outcomes, which is especially true in smallholder systems that are highly prone to risks and diversification.

Livelihood, food security, and resiliency results

A literature is increasingly growing outside the realm of productivity to look at wider livelihood outcomes, such as food security, dietary diversity, asset accumulation and resilience to shocks. Recent research based on nationally representative panel data on Ghana indicates that access to extension services is positively correlated with better food consumption, dietary diversity and household asset holdings, where extension is instituted by farmer-based organizations (Aremu *et al.*, 2025) ^[3]. In Africa, other related studies indicate that the extension participation is positively associated with the household welfare but with a diverse impact depending on the context and model of delivery (Ragasa *et al.*, 2013; Nwafor *et al.*, 2021) ^[17, 14].

Resilience outcomes Resilience outcomes are less commonly measured, but becoming increasingly popular in the extension literature, e.g., coping with the variability in climate or economic shocks. There is some evidence that extension that promotes climate-smart practices and diversification can increase adaptive capacity, but these effects are often observed over longer periods of time than those time horizons addressed by most evaluations (Danso-Abbeam *et al.*, 2022) ^[7]. This time discrepancy is still a major weakness of the evidence base.

Social and institutional outcomes

The other developmental roles of extension are measured in social and institutional outcomes other than performance, technical and economic. Such results are gender inclusion, empowerment, formation of social capital and collective action. According to African gender-oriented literature, there is invariably institutional bias, time and socio-cultural constraints, which restrict access to and benefits by women farmers through extension systems (Ragasa *et al.*, 2013; Doss *et al.*, 2018) ^[17, 9]. In other cases where the extension programs have intentionally integrated gender sensitive

practices, there are signs indicating that women have an enhanced inclusion, decision making process and access to productive resources.

The results of collective action, which include; the increased strength of farmer organizations, social learning networks are also reported especially in participatory extension frameworks like Farmer Field Schools. Research indicates that such strategies do increase trust, peer learning and cooperation that have the potential to indirectly contribute to adoption and livelihood gains (Davis *et al.*, 2012). Nevertheless, technical or economic indicators are more consistently measured than social and institutional ones, which makes them less represented in policy discussions despite their impact in the long-term.

Ways of determining extension effectiveness

The methodological scope used in the literature on the effectiveness of agricultural extension in Ghana and Sub-Saharan Africa varies, which is due to the differences in the goals of the research, data access and assessment opportunities. Depending on how they can achieve causality, measure longer-term outcomes, as well as capture complex social processes, these methods differ significantly. This part summarizes the prevailing quantitative and qualitative and mixed-methods strategies in assessing extension, analyses major measurement issues, and omits the merits and shortcomings of the current methods.

Measures of quantitative impact evaluation

The empirical extension literature is dominated by quantitative impact evaluation methods, especially studies aiming to estimate causal effects of extension interventions on outcomes of adoption, productivity and income. In many respects, randomized controlled trials (RCTs) are considered as the gold standard of causal inference since random assignment reduces the chances of selection bias and confounding (Duflo, Glennerster, and Kremer, 2007) ^[10]. RCTs have similarly been employed to assess discrete interventions, like informational delivery systems, training initiatives and computer-based advisory services, with internally valid estimates of the short-term effects being commonly obtained (Fabregas *et al.*, 2019; Aker *et al.*, 2016) ^[11, 2].

In such cases when randomization is impractical, one tends to use quasi-experimental designs. These are propensity score matching, difference-in-differences and instrumental variable methods and regression discontinuity designs. Quasi-experimental econometric regression analysis with household level and plot-level survey data have been widely applied in Ghana to determine the impact of access to extensions in the adoption of technology, household and welfare outcomes (Benin *et al.*, 2012; Abdul-Rahaman and Abdulai, 2018) ^[4, 1]. Although these methods are more useful than mere cross-sectional comparisons, there are robust assumptions regarding the process of selection and unobserved heterogeneity, which are not always testable. Observational econometric models are still also common, especially when nationally representative survey or administrative data are used. These methods have wide coverage and policy applicability but are more susceptible to endogeneity and measurement error, which tend to cause apprehensive interpretation of estimated effects (Ragasa *et*

al., 2013) ^[17]. Consequently, the positive but small effects of extensions are often statistically significant but with broad confidence ranges with context-dependent findings.

Mixed methods and qualitative methods

The qualitative and mixed methods methodologies are an important complement to the assessment of the effectiveness of extension, especially in the evaluation of the mechanism, perceptions and institutional dynamics that might be undervalued by quantitative approach. The use of case studies, focus group discussions, key informant interviews and participatory rural appraisal techniques has been common in understanding the experience of farmers on extension services, interpretation and adaptation of knowledge and the varying adoption decisions among households and communities (Chambers, 1994; Davis *et al.*, 2012) ^[6, 8].

Participatory evaluations like those gained during the Farmer Field School programs are those that focus on experiential learning, social interaction and empowerment outcomes. Experience in East and West Africa demonstrated that such strategies may also expose significant social and behavioral transformations, such as enhanced problem-solving, common action and confidence, 2 that are hard to measure using conventional econometric indicators (Davis *et al.*, 2012) ^[8]. Mixed-methods research papers involve both quantitative estimates of impact and qualitative information, which provide a more comprehensive view of the process and results of extension. Recent reviews believe that this type of integrative designs fit better in pluralistic extension systems, in which effectiveness is influenced by a variety of actors and pathways (Nwafor *et al.*, 2021) ^[14].

Indicators and measurement issues

One of the biggest obstacles in measuring success of extension is how to select and measure relevant indicators. Most of the studies are based on proxy variables, including extension contact or participation that are not sufficient to understand the intensity, quality or relevance of advisory services obtained (Birner *et al.*, 2009) ^[5]. Outcome indicators are also a varied lot, including knowledge scores and adoption dummy variables, yields, income and subjective welfare indicator. This heterogeneity makes cross-study comparisons difficult and quantitative meta-analysis difficult.

Measures are further limited by temporal incompatibilities. Knowledge and adoption outcomes can be short-term and productivity, income and resilience effects may be more long-term. Short time periods will thus run the risk of not properly recognizing the actual extension effects (Ragasa *et al.*, 2013) ^[17]. Social outcomes with measurement issues are especially acute, in the case of empowerment, inclusion and institutional change, which are context-specific and not often standardized (Doss *et al.*, 2018) ^[9].

Advantages and drawbacks of prevailing approaches

All methodological tools applicable to evaluate the effectiveness of the extension have their own advantages and disadvantages. Experimental and quasi-experimental designs have more causal information and can be used to test a specific intervention, but tend to have small scopes of interest and could not be externally validated across a wide

range of farming systems (Duflo *et al.*, 2007; Fabregas *et al.*, 2019) ^[10, 11]. Observational forms of econometric design have a greater coverage and policy implications but are limited to endogeneity and measurement error.

Qualitative and participatory methods are good at the context, institutional and social change, but are subject to generalizability problems and researcher subjectivity issues (Chambers, 1994) ^[6]. Mixed-methodology designs help to reduce some of these limitations through the triangulation of evidence, though they are more costly and taxing to methodological expertise.

Agricultural extension as an institutional model

The extension of agriculture in Ghana and Sub-Saharan Africa follows a wide variety of institutional models as it can be traced back to the historical developments and the reforms of policies and the changing paradigms of development. These models vary in terms of governance structure, funding mechanisms, incentives and target population of which both influence extension effectiveness. Knowledge of the institutional diversity is then the key towards understanding the evidence regarding the outcome of extension and the explanation of the variation in different settings.

The extension systems that are available in the public sector

In much of Sub-Saharan Africa, the advisory service delivery system continues to rely on the public-sector extension systems. Such systems are usually based in ministries of agriculture and are usually funded by government budgets, and are mandated to offer a broad based, inclusive services to farming communities. In Ghana, there is a history of the staple crop-based public extension coordinated by the Ministry of Food and Agriculture and implemented on a decentralized district basis in the process of reducing food security and poverty (Benin *et al.*, 2012) ^[4].

Empirical evidence suggests that the positive impacts of public extension systems may be attained when the systems are broadly covered and the capacity of the agents is not excessively high. Nevertheless, African reviews always find structural bottlenecks that include high extension agent to farmer ratios, operational funding, poor incentives and logistic difficulties that lower the intensity and effectiveness of services (Ragasa *et al.*, 2013) ^[17]. This leads to small and disproportional impacts on the population in most cases of public extensions particularly in distant or resource limited locations.

Extensions of private and commercial services

Market-oriented agricultural development and commercialization efforts have increased, which has been met by the growth of private and commercial extension services. They are often provided by agribusiness companies, supplier of inputs, commodity purchasers and consulting organizations, and are usually incorporated in the contract farming or outgrower programs. Theoretical attractiveness of the privatization of the extension is the better performance incentives, the more appropriate performance to the market needs and more specialization of the technical areas (Birner *et al.*, 2009) ^[5].

African evidence indicates that private extension may be useful in encouraging the adoption of high-value crops, quality standards and input-intensive practices amongst commercially oriented farmers. Its scope is however usually restricted to farmers with purchasing power or market access which raises the question of leaving smallholders, women and poorer producers out (Ragasa, 2019) ^[16]. Therefore, it is found that extension of the services privately will not be substitutionary to the provision of such services by the government, especially in the staple food systems.

Extension Models Led by NGOs and Donors

The extension models that have been implemented by NGOs and donors have contributed largely to agricultural development in Sub-Saharan Africa especially where there is weak capacity on the part of the government. Such models tend to focus on participatory methodology, building of capacity, dissemination of innovation and social inclusion. New approaches are often tried on donor-funded projects, including Farmer Field Schools, gender-responsive extension and climate-smart agriculture (Davis *et al.*, 2012) ^[8].

Experimental analyses demonstrate that NGO-led extension would yield high learning and adoption results at regional levels particularly when the interventions are resource endowed and participatory. African scholars, however, warn that the donor-led models might have lack of scalability, sustainability issues and disintegration after termination of external funding (Birner *et al.*, 2009; Ragasa *et al.*, 2013) ^[5, 17]. These restrictions make them hard to be effective in national extension systems in the long run.

Community-driven and Farmer-based Approaches

The community-led and farmer-based extension strategies place farmers in the active knowledge production and sharing. Such models are lead farmer systems, farmer-to-farmer extension, cooperatives and producer organizations. Their approach is based on the theory of social learning and it places a heavy focus on peer interaction, trust and local relevance (Chambers, 1994) ^[6].

The Ghana and other African research indicate that learning, adoption and collective action can be improved through farmer-based methods especially where there are strong social networks and farmer organizations that are functional (Davis *et al.*, 2012) ^[8]. These methods can be cost effective and those that are culturally entrenched. Nevertheless, their efficiency could be determined by the ability of farmer leaders and inclusiveness of community institutions, without protection, such initiatives can replicate the local power structures and marginalize the groups (Doss *et al.*, 2018) ^[9].

Pluralistic and Hybrid Systems

Pluralistic extension systems conceptualize the coordination of various providers (public agencies, private firms, NGOs and farmer organizations) into a coordinated system. The model has become a popular feature in African extension policy due to fiscal limitations and the demand of specialized and context-specific services (Birner *et al.*, 2009) ^[5].

Pluralism in Ghana is manifested through the co-existence of governmental provision of extension services, donor initiatives, market-based and digital advisory services and

market-based services. Although pluralistic systems may provide possible benefits in coverage, innovation, and flexibility, empirical studies indicate that coordination failures, unequal quality control and overlapping mandates are the common challenges (Ragasa, 2019) ^[16]. In the absence of proper governance and management, pluralism can compromise accountability and erode effectiveness of extensions.

Comparative Extension Effectiveness Amongst Models

Relative evaluations indicate that there is no one institutional model that can always be effective in all results and situations. Equity and wide reach Public extension systems are essential, but limited because of their resource needs; commercial extension has strong commercial potential but can lead to exclusion; NGO-led models are effective at innovation but have a sustainability constraint; and farmer-based systems can facilitate social learning but are uneven in terms of inclusiveness (Birner *et al.*, 2009; Ragasa *et al.*, 2013) ^[5, 17].

African reviews are now also making the case that effectiveness lies not necessarily in the form of provider, but in how the institutional set-up is able to coordinate (and to provide links) advisory provision with complementary inputs, markets and policies (Nwafor *et al.*, 2021) ^[14]. The most promising seem like hybrid systems which are a combination of public control and private effectiveness, the participatory approaches and digital technologies, as long as they are directing by the policy of inclusiveness and strong accountability systems. In addition to certain delivery models and assessment approaches, a number of cross-cutting variables always determine the performance of agricultural extension in Ghana and Sub-Saharan Africa. These considerations determine the beneficiaries of extension, the mode of service delivery and long term implications.

The gender, youth, and social inclusion dimension deals with issues pertaining to the aspect of gender and social inclusion, particularly among the youth. The issue of gender and social inclusion continues to be a major challenge to the extension systems in Africa. Despite the significant proportion of women who also constitute a significant number of agricultural labor force, it is always found that they are less likely to access extension services compared to men because of the socio-cultural practices, lack of time, and inability to own land and also because of the staffing of the extension services by the male workers (Ragasa *et al.*, 2013; Doss *et al.*, 2018) ^[17, 9]. In Ghana, research shows that despite women obtaining extension information, they tend to be confined to act on the same by the fact that they have little control over inputs and household decision-making (Abdul-Rahaman and Abdulai, 2018) ^[1].

The same thing is true with youth inclusion. Although extension policy is paying more focus to the importance of youth involvement in the quest to transform agriculture, there are few empirical studies on youth-specific extension. According to the available literature, extension methods that are based on the combination of entrepreneurship, digital technologies and market-related skills prove more efficient in terms of attracting young farmers than old-fashioned advisory models (Ragasa, 2019) ^[16]. All in all, the effectiveness of extensions is lower when the services do

not consider the differentiated needs and constraints in gender, age and social groups.

ICT-based and Digital Extension

ITC and digital-based extension has become a noticeable reaction to coverage and cost issues in the African extension systems. The agricultural information is being disseminated at scale through mobile phones, radio, interactive voice Response and smartphone application. Available experimental and quasi-experimental research evidence suggests that digital extension may enhance access to timely information and adoption of an improved practice among farmers, especially when digital technologies are in addition to face-to-face interactions (Aker *et al.*, 2016; Fabregas *et al.*, 2019) ^[2, 11].

But there are other inequalities brought by digitalization. Literacy, being able to own a phone, network coverage and gender norms influence access to digital extension and leave out poorer and female farmers (Ragasa, 2019) ^[16]. Furthermore, the research warns that the digital intervention through information alone might not be effective in productivity and income without the support of other complementary services like input access, credit and markets. Digital extension, therefore, reforms, though not abolishes old debates of effectiveness.

Capacity Limitations and Motivation Systems

One of the most long-term obstacles to the effectiveness of extensions is human and institutional capacity constraints. In Ghana and Sub-Saharan Africa, the service quality and intensity are compromised by high agent-to-farmer ratios, scarce training, poor logistics system, and a weak performance incentive (Benin *et al.*, 2012; Ragasa *et al.*, 2013) ^[4, 17]. Institutions In the case of the government, the agents working in the field are usually confronted with conflicting administrative duties, limiting time to spend on the field.

Rewards systems are also important. Where the extension agents do not have well defined performance measures or performance based rewards such as career advancement, motivation and accountability can be compromised. On the other hand, stronger incentives are commonly used in the private and project-based systems, which can also focus on commercially viable farmers. According to the literature, the strategy of matching the incentives with inclusive goals and outcome-oriented goals is essential in enhancing the effectiveness of the extension (Birner *et al.*, 2009) ^[5].

Policy, Governance, and Financing Environments

The enabling environment of extension is determined by policy coherence, arrangements of governance and the level of financing. The policies of decentralization and pluralism in Ghana have increased the pool of providers of extension, but they have also raised the problems of coordination (Benin *et al.*, 2012) ^[4]. Underfunding of public extension is a significant limitation in Africa and constrains the number of staff, mobility, and capacity of operation (Ragasa *et al.*, 2013) ^[17].

Donor reliance also complicates the process of governance since when the project is financed externally, it is possible that it will have parallel systems with little integration into the national systems. The research highlights that the long-

term functionality is necessity to maintain a steady funding, institutional requirements, and coordination processes that align the activities of the public, private and non-state entities (Birner *et al.*, 2009) ^[5].

Synthesis and Discussion

What is working and what is not, as well as the conditions

The synthesis of the evidence reviewed indicates that, in general, agricultural extension is successful in enhancing knowledge and adoption outcomes, although its effects on productivity, income, and livelihoods tend to be small and context-specific. When the advice is relevant, repeated, participatory and connected with other supplementary services like provision of inputs and access to markets, the extension interventions are more effective (Davis *et al.*, 2012; Benin *et al.*, 2012) ^[8, 4]. On the other hand, individual trainings, informational only interventions and poorly-resourced systems of the general population are likely to have restricted or temporary effects.

Cohesion in the Outcomes, Methods, and Institutional Models

One of the most important lessons of the review is that the outcomes of the extensions, the evaluation approaches, and models of the institutions often fail to coincide. Knowledge and adoption outcomes are usually used since these are easier to monitor in short-term research whereas even the livelihood and social outcomes are less popular. Experimental studies can be narrowly based on interventions, but observational studies examine the broader systems but have a problem of causality. The models of participation and inclusion in institutions are not often assessed by indicators that would represent empowerment or social change (Ragasa *et al.*, 2013; Doss *et al.*, 2018) ^[17, 9].

Ghana in a comparative sub-Saharan African view

The experience of extension in Ghana can be seen more broadly: the foundation of a robust public sector, the rise of pluralism, the rise of digital experimentation, and inadequate capacity growth. Ghana has comparatively good data availability and the policy frameworks as compared to most of the countries in Sub-Saharan Africa making it possible to conduct more rigorous evaluations (Benin *et al.*, 2012) ^[4]. Nonetheless, issues of coordination, inclusion and sustainability are similar to those within the region at large implying that the Ghana experience has lessons of both growth and chronic constraints.

Theoretical, Policy, and Practice Implications

The results support the importance of the diffusion theory, system of innovation thinking and participation model in interpreting the effectiveness of extensions. To policy and practice, the evidence suggests hybrid extension systems that entail a mix of public control, private efficiency, participatory strategies and digital tools, and based on policies to embrace the need as well as consistent funding. Methodologically, the review demonstrates the necessity to develop evaluation designs that would represent more long-term and multi-dimensional outcomes.

Literature Gaps and Future Research Directions

There are a number of gaps that arise after the review. Methodologically, there is little application of longitudinal designs that can represent sustained livelihood and resilience results. On the outcome front, the areas of empowerment, social capital and institutional change have not been adequately addressed as compared to the adoption and productivity measures. There are few studies which explicitly compare the extension models or determine the coordination of the pluralistic systems institutionally. To enhance the strength of policy-based evidence future research ought to focus on mixed-methods, standardized outcome measure and comparative institutional analysis.

Conclusion

This systematic review shows that extension in agriculture in Ghana and Sub-Saharan Africa generates overall positive but not uniform results that are conditioned by the institutional design, methods of delivery and situational aspects. It is common in terms of knowledge and adoption gains, and productivity, livelihood and social impacts on sustained engagement and enabling environment. To make extension systems stronger, one should abandon individual-model solutions and shift to the approach of coordinated, inclusive, and well-equipped hybrid solutions. The evidence to policy-makers is that to improve the effectiveness and sustainability of agricultural extension systems, policy-makers need to ensure that the extension investments are gendered to respond to the needs of the digital, capacity and long-term financing.

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