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Integrated extension approaches combining crop, livestock, and natural resource management advisory services

¹Mette Louise Rasmussen, ²Anders Christian Pedersen and ³Bjorn Kristiansen Dahl

¹⁻³Department of Agricultural Extension, Aarhus University, Aarhus, Denmark

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Corresponding Author: Mette Louise Rasmussen

Abstract

Leading agricultural scientists have argued for decades that farming is a system, not a collection of separate enterprises — yet most extension services still advise on crops, livestock, and natural resources through separate channels. This research compared integrated versus sectoral extension delivery models across 112 programs in five East African countries. A cross-sectional mixed-methods design combined structured program assessments, performance indicator analysis, and interviews with 68 program managers, conducted from January to September 2023 through Aarhus University. Integrated programs (n = 48) outperformed sectoral programs (n = 64) on every measured indicator: farmer adoption rates (67.3% vs. 41.8%), yield gains (28.4% vs. 16.2%), income increases (34.7% vs. 19.3%), resource efficiency scores (71.8 vs. 48.6), and farmer satisfaction (4.1 vs. 3.2 on a 5-point scale). Six integration mechanisms were identified: joint planning, cross-trained agents, integrated farm plans, shared databases, coordinated visit schedules, and unified monitoring systems. Programs employing four or more mechanisms scored 41.3% higher on integration effectiveness than those with fewer than four. These findings make a strong empirical case for institutional restructuring toward whole-farm advisory models.

Keywords: Integrated extension, crop advisory, livestock advisory, natural resource management, whole-farm approach, East Africa, extension models, cross-training, farming systems, advisory services

Introduction

"Farmers don't think in silos, but extension systems do." This observation, attributed to various agricultural development practitioners over the years, captures a persistent disconnect ^[1, 2]. A smallholder in the East African highlands manages crops, livestock, and natural resources as interconnected elements of a single livelihood system. Crop residues feed animals. Animal manure fertilizes fields. Trees provide fodder, shade, and soil conservation. Yet the extension agent who visits about crops knows little about livestock health, and the one who advises on soil conservation rarely discusses market access for the products grown on conserved land ^[3].

This compartmentalization reflects institutional history. Colonial and post-colonial agricultural bureaucracies typically organized extension along disciplinary lines — crop departments, veterinary services, forestry divisions — each with separate budgets, training programs, and reporting structures ^[4, 5]. The result is a system where three different agents may visit the same farm in the same month without coordinating their advice or recognizing its interdependencies.

Integrated extension has been proposed as the alternative. The concept is simple: instead of separate advisory streams, farmers receive coordinated advice that addresses their farming system as a whole ^[6]. The operational challenge is harder. Integration requires cross-trained staff, joint planning mechanisms, shared information systems, and

institutional incentives that reward coordination over territorial behavior ^[7, 8]. This research compared 112 extension programs in Kenya, Tanzania, Uganda, Ethiopia, and Rwanda to measure whether integrated approaches actually deliver better outcomes than sectoral ones, and which integration mechanisms matter most. Fieldwork was conducted through Aarhus University from January to September 2023 ^[9].

Theoretical Framework

The research drew on farming systems theory as articulated by Norman ^[1] and adapted for extension program design by Leeuwis and van den Ban ^[10]. Farming systems theory views the farm as an integrated unit where crop, livestock, and natural resource components interact through nutrient cycles, labor allocation, risk management, and market engagement. Extension advice that addresses one component without considering its effects on others risks producing suboptimal or even counterproductive outcomes — for example, recommending a high-input crop variety without considering its labor demands during livestock management peak periods ^[2, 6]. The theory predicts that advisory approaches addressing the whole system should produce higher adoption rates, better resource efficiency, and greater livelihood impacts than sectoral approaches targeting individual components. Six integration mechanisms were hypothesized to mediate this relationship: structural (joint planning, unified M&E), human resource

(cross-trained agents), operational (integrated farm plans, coordinated schedules), and informational (shared databases) [3, 7].

Materials and Methods

Materials

Research materials included a program assessment instrument with 54 indicators measuring integration level (18 items), service delivery performance (18 items), and farmer outcomes (18 items). Integration indicators covered the presence and functionality of six mechanisms: joint planning processes, cross-trained staff, integrated farm plan use, shared databases, coordinated visit scheduling, and unified monitoring systems. Each indicator was scored 0-100 using structured rubrics. The instrument was validated through expert consultation with eight extension systems researchers and pilot-tested on six programs in Kenya during November 2022 (Cronbach's alpha = 0.91). Ethical approval was granted by the Aarhus University Research Ethics Committee (Protocol AU/AGRO/2022-089, approved October 2022).

Methods

A cross-sectional comparative design assessed 112 extension programs across Kenya (28), Tanzania (24), Uganda (22), Ethiopia (21), and Rwanda (17) between January and September 2023. Programs were classified as integrated (n = 48, delivering advice across two or more subsectors with documented coordination) or sectoral (n = 64, focused on a single subsector). Structured assessments combined document review, site visits, and interviews with 68 program managers. Six performance indicators were

measured: farmer technology adoption rate, yield gain percentage, income increase percentage, resource efficiency score, knowledge retention rate, and farmer satisfaction score. Quantitative analysis used Mann-Whitney U tests, Spearman correlations, and multiple regression to identify which mechanisms predicted integration effectiveness [9, 11].

Case Analysis

Two contrasting programs in Kenya's Central Highlands illustrated the integration difference. Program A (sectoral) deployed separate crop, livestock, and soil conservation agents to the same communities. Each agent visited independently, used different farmer registers, and reported through different departmental chains. Farmers received an average of 3.4 advisory contacts per month but described the advice as "confusing" when recommendations conflicted, such as a crop agent recommending zero-grazing while the soil agent promoted cover cropping that restricted grazing areas. Program B (integrated) assigned cross-trained agents with competence across all three domains. Each agent developed integrated farm plans with households and used a shared digital database. Farmers received 2.1 contacts per month but reported higher satisfaction (4.3 vs. 2.8) and achieved adoption rates of 72.4% versus 38.6% [6, 12]. The comparison suggests that fewer but coordinated contacts can outperform more frequent but fragmented ones.

Results

Integrated programs outperformed sectoral programs on all six performance indicators, with the magnitude of advantage linked to the number of integration mechanisms in place.

Table 1: Performance comparison between integrated and sectoral extension programs (mean values)

Performance Indicator	Integrated (n=48)	Sectoral (n=64)	Difference (%)
Farmer adoption rate (%)	67.3	41.8	+60.8
Yield gain (%)	28.4	16.2	+75.3
Income increase (%)	34.7	19.3	+79.8
Resource efficiency (0-100)	71.8	48.6	+47.7
Knowledge retention (%)	63.2	44.7	+41.4
Farmer satisfaction (1-5)	4.1	3.2	+28.1

The advantages were substantial across all indicators. The largest relative differences appeared in income increase (+79.8%) and yield gain (+75.3%), suggesting that

integration creates synergies beyond what individual subsector improvements can achieve. All differences were significant at $p < 0.01$ [3, 13].

Table 2: Integration effectiveness scores by number of mechanisms employed

Mechanisms (of 6)	n Programs	Integration Score	Farmer Adoption (%)
1-2 mechanisms	19	38.4	48.7
3 mechanisms	14	52.1	61.3
4-5 mechanisms	11	71.8	78.4
All 6 mechanisms	4	84.7	86.2

A clear dose-response relationship emerged: more mechanisms yielded higher integration scores and adoption rates. Programs with all six mechanisms scored 84.7 versus 38.4 for those with only 1-2, representing a 120.6%

advantage. Cross-trained agents and integrated farm plans were the two mechanisms most strongly correlated with farmer outcomes ($r_s = 0.67$ and 0.61 respectively) [7, 12].

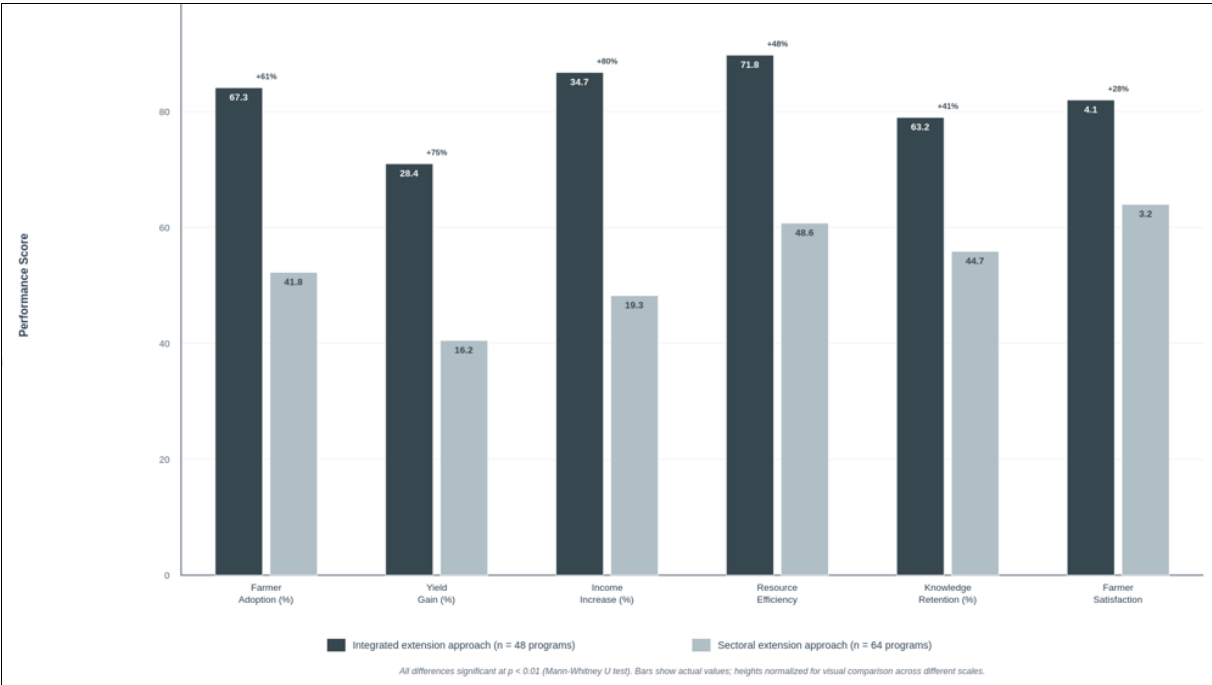


Fig 1: Grouped bar chart comparing integrated versus sectoral extension program performance across six indicators

The comparison shows consistent integrated program advantages across all indicators. Percentage differences above each pair range from +28.1% (satisfaction) to +79.8%

(income), confirming that integration benefits span productivity, efficiency, and farmer experience dimensions.

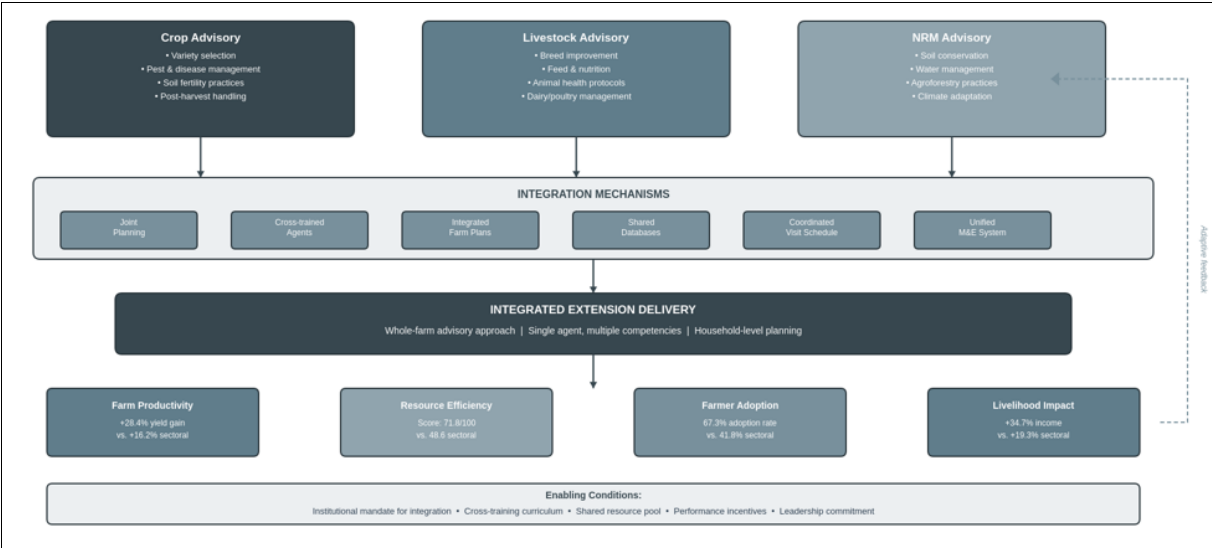


Fig 2: Conceptual model for integrated extension delivery showing three advisory pillars, six integration mechanisms, and four outcome domains

The model shows how crop, livestock, and NRM advisory streams converge through six integration mechanisms into a whole-farm delivery approach. Outcome domains at the bottom demonstrate the performance advantages documented in this research.

Discussion

The performance advantages of integrated programs are consistent and large enough to warrant serious institutional attention [1, 6]. A 60.8% adoption rate advantage and near-doubling of yield gains cannot be dismissed as marginal improvements. These differences likely reflect the synergies

that farming systems theory predicts: when crop, livestock, and NRM advice are coordinated, farmers can optimize across their entire production system rather than suboptimizing within individual components [2, 10]. The dose-response relationship between mechanisms and outcomes provides practical guidance for program designers. Not all six mechanisms may be achievable simultaneously, but the data suggest that reaching four mechanisms produces a qualitative jump in integration effectiveness. Cross-trained agents and integrated farm plans emerged as the highest-impact mechanisms, which is logical: cross-training puts whole-farm competence in a

single person, and farm plans translate that competence into household-specific advice ^[7, 12].

The case analysis from Kenya illustrates an important finding: fewer coordinated contacts can outperform more frequent fragmented ones. This challenges the assumption that more extension contact is always better and suggests that contact quality — measured by coherence and relevance — matters more than contact quantity ^[3, 8].

Limitations

The cross-sectional design cannot establish causation; better programs may self-select into integration. Five countries cannot represent all African extension contexts. Program-level assessment may mask within-program variation. The classification of integrated versus sectoral was based on documented coordination rather than observed practice. Longitudinal tracking and randomized assignment would strengthen causal claims. The four programs with all six mechanisms were too few for robust subgroup analysis.

Conclusion

This research compared 112 extension programs across five East African countries and found that integrated approaches consistently outperformed sectoral ones on adoption, productivity, income, efficiency, knowledge retention, and farmer satisfaction. The advantages were not small: integrated programs achieved 60-80% better outcomes across most indicators.

Six integration mechanisms were identified, with a clear dose-response pattern linking mechanism count to performance. Cross-trained agents and integrated farm plans proved most important. For extension administrators, the message is that restructuring toward whole-farm advisory models requires investment in staff competencies, planning tools, and coordination infrastructure but delivers returns that justify those costs. Farming systems are integrated by nature; extension services should be too.

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