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Resources Require Mindset: The Mediating Role of Entrepreneurial Orientation in Smallholder Mango Value Chains in Kenya

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Abstract
Background: *As the global agricultural sector confronts the dual imperatives of feeding a population projected to reach 9.7 billion by 2050 and mitigating severe environmental degradation, the transformation of subsistence smallholder farming into sustainable commercial enterprises is essential (United Nations, 2015). Despite substantial investments in agripreneurship interventions across Sub-Saharan Africa, commercialization outcomes remain highly inconsistent (Alliance for a Green Revolution in Africa, 2017). This study investigates the behavioural "black box" of agricultural support, examining how a farmer's Entrepreneurial Orientation (EO) mediates the relationship between external agripreneurship interventions (skills, resources, networks, and technical support) and the sustainable production of smallholder mango value chains (Miller, 1983).*
Methodology: *The study is anchored in a pragmatism philosophical paradigm, employing a convergent parallel mixed-methods, cross-sectional survey design. Data was collected from 366 smallholder mango farmers in Makueni County, Kenya, utilizing a multi-stage stratified random sampling technique across the Kaiti and Makueni sub-counties. Construct validity and data reduction were achieved via Principal Component Analysis (PCA). Hypothesis testing and mediation analysis were conducted using Ordinary Least Squares (OLS) regression through the PROCESS Macro (Model 4), utilizing 5,000 bootstrap samples to estimate direct and indirect effects (Hayes, 2018).*
Findings: *The empirical analysis reveals that all four dimensions of agripreneurship support exert a statistically significant positive direct impact on the Triple Bottom Line (TBL) sustainability of smallholder farms (Elkington, 1997). Crucially, the behavioural mechanism of EO selectively amplifies these interventions. EO significantly mediates the relationship between resource support and sustainable production (ab = 0.0391, BootCI [0.0191, 0.0592]), as well as networking support and sustainable production (ab = 0.0338, BootCI [0.0142, 0.0524]). Conversely, EO does not significantly mediate skills support or technical support, indicating these are universal hygiene factors that bypass behavioural bottlenecks.*
Conclusions: *This research advances the Behavioural Resource-Based View (RBV) and Social Network Theory within agricultural economics. It demonstrates that physical agricultural resources and artificially engineered market networks are functionally latent; they require the proactive, innovative, and risk-taking mindset of the farmer to be translated into sustainable economic, social, and environmental outcomes.*
Recommendations: *The findings provide an evidence-based framework for policymakers and non-governmental organizations (NGOs) to re-engineer agricultural development programs. Institutions must transition from purely structural hardware provision to psychological software empowerment, utilizing EO assessments as a beneficiary screening tool for capital-intensive resource and networking interventions.*

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I. INTRODUCTION

1.1 Background of the Study

The capacity of the global ecosystem to support its rapidly expanding population represents the most critical challenge of the 21st century. The United Nations projects that the global population will reach 9.7 billion by 2050, a demographic surge that will effectively double the demand for food products globally (United Nations, 2015). The vast majority of this population growth will be concentrated in developing and emerging economies across Asia and Africa. Concurrently, agricultural systems are under unprecedented pressure from

climate change, diminishing natural resources, and the degradation of arable land resulting from historically unsustainable intensification practices. Consequently, the global agricultural sector is positioned simultaneously as a major contributor to environmental degradation, a victim of climate volatility, and the primary mechanism for achieving sustainable human development.

Within Sub-Saharan Africa (SSA), smallholder farmers dominate the agrarian landscape, generating approximately 80 percent of the food commodities consumed across the continent and constituting the largest private-sector demographic (Herrero et al., 2017). In Kenya, smallholders contribute 75 percent of the total agricultural output and market 70 percent of all agricultural produce (Herrero et al., 2017). Despite this profound systemic importance, the latent potential of smallholder farmers to commercialize their operations, ensure food security, and create extensive rural employment is persistently hindered by acute structural and operational bottlenecks. These constraints include restricted access to capital, weak market integration, deficient technical knowledge, and profound vulnerability to climatic and phytosanitary shocks.

To mitigate these challenges and align with the United Nations Sustainable Development Goals (SDGs) specifically SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 12 (Responsible Consumption and Production), international development institutions, national governments, regional governments, and localized non-governmental organizations (NGOs) have deployed vast financial and technical resources into rural agrarian ecosystems. These interventions are increasingly conceptualized under the paradigm of "agripreneurship," reflecting a strategic shift from treating smallholders merely as subsistence farmers to positioning them as resilient, commercial agribusiness operators.

The mango subsector in Makueni County, Kenya, serves as a key location for observing the dynamics of agripreneurship interventions. Classified largely as Arid and Semi-Arid Lands (ASALs), Makueni has successfully pivoted to commercial mango production as a climate-adaptive economic strategy. The county currently harbours an estimated 4 million mango trees producing over 200,000 metric tons annually, rendering it Kenya's foremost mango producer and generating a subsector valuation exceeding 4 billion Kenyan Shillings (Government of Makueni County [GMC], 2018). Over the past decade, Makueni smallholders have been the recipients of intensive, multi-stakeholder support initiatives. The National Agriculture and Livestock Extension Programme (NALEP), TechnoServe's YieldWise project, the United States Agency for International Development (USAID), and the Makueni County Government have collectively invested in capacity building, subsidized agricultural inputs, biological pest control methodologies, and major infrastructure, including the 600-million-shilling Kalamba Fruit Processing Plant (GMC, 2018).

1.2 Problem Statement

Despite the synchronized and heavily capitalized mango farmer support interventions in Makueni County, the outcomes at the farm level remain highly inconsistent. While some smallholder farmers have successfully integrated into premium export value chains and localized processing clusters, a significant proportion continue to experience post-harvest losses of up to 40 percent, cyclical market exploitation by informal brokers, and devastating export bans triggered by fruit fly infestations. The persistence of these vulnerabilities among populations that have received identical developmental support exposes a critical "black box" in development economics: the assumption that the exogenous provision of resources, networks, and training automatically translates into sustainable agricultural performance.

This study posits that the missing determinant in the efficacy of agripreneurship interventions is the internal behavioural mechanism of the beneficiary, specifically their Entrepreneurial Orientation (EO) (Miller, 1983). EO defines a farmer's intrinsic propensity for innovativeness, proactiveness, and risk-taking (Miller, 1983). While traditional agricultural economics frequently models structural support as having a direct, unmediated impact on farm performance, this analysis argues that resources and networks are inherently latent. They demand an entrepreneurial agent to activate them.

1.3 Purpose of the Study

By analysing the behavioural traits of agricultural development, this study sought to provide empirical pathways for policymakers to redesign intervention mechanisms, moving from monolithic aid distribution toward targeted, mindset-driven sustainability frameworks.

1.4 Objective of the Study

The primary objective of this research was to analyse the mediating role of entrepreneurial orientation in the relationship between categorized agripreneurship support interventions (skills, resources, networking, and technical assistance) and the sustainable production of smallholder mango farms in Makueni County.

1.5 Hypotheses of the Study

The study sought to establish the following direct and indirect hypotheses:

Direct Path Hypotheses:

H_1: Entrepreneurship skills support has a significant positive effect on the sustainability of smallholder mango

production in Makueni County.

H_2: Entrepreneurial resource support has a significant positive effect on the sustainability of smallholder mango production in Makueni County.

H_3: Entrepreneurial networking support has a significant positive effect on the sustainability of smallholder mango production in Makueni County.

H_4: Farmer technical support has a significant positive effect on the sustainability of smallholder mango production in Makueni County.

Mediation Path Hypotheses:

H_{5a}: Entrepreneurial orientation significantly mediates the relationship between entrepreneurship skills support and sustainable smallholder mango production.

H_{5b}: Entrepreneurial orientation significantly mediates the relationship between entrepreneurial resource support and sustainable smallholder mango production.

H_{5c}: Entrepreneurial orientation significantly mediates the relationship between entrepreneurial networking support and sustainable smallholder mango production.

H_{5d}: Entrepreneurial orientation significantly mediates the relationship between technical support and sustainable smallholder mango production.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

To systematically evaluate the complex interdependencies between external support programs, farmer psychology, and sustainable production, this research analysed three theoretical perspectives: the Entrepreneurship Development Systems (EDS) Theory, the Theory of Entrepreneurial Orientation (EO), and the Triple Bottom Line (TBL) approach.

2.1 Entrepreneurship Development Systems (EDS) Theory

This study relied on the Entrepreneurship Development Systems (EDS) Theory in the conceptualization of the independent variables. The EDS was initially developed by the Corporation for Enterprise Development (CFED, 2008). The EDS framework posits that effective rural economic development cannot be achieved through isolated, ad-hoc interventions. Instead, it requires a comprehensive, integrated ecosystem of services tailored to meet the specific environmental and operational constraints of local entrepreneurs (CFED, 2008).

According to the CFED, a highly functional EDS encompasses five essential pillars: entrepreneurship education, adult technical training, access to capital, access to networks, and the cultivation of an entrepreneurial culture (CFED, 2008). Adapted for the smallholder agricultural context, this study consolidated these pillars into four discrete constructs of agripreneurship interventions:

1. **Entrepreneurial Skills Support:** Encompassing core opportunity recognition, business management acumen, and basic operational competencies.
2. **Entrepreneurial Resource Support:** The provision of tangible assets, including land tenure security, micro-capital, and qualified human labour.
3. **Entrepreneurial Networking Support:** The facilitation of linkages to downstream markets (processors, exporters) and upstream suppliers (agrovets, microfinance institutions).
4. **Entrepreneurial Technical Support:** The deployment of localized extension services, specialized diagnostic testing (e.g., soil and fruit quality), and advanced informational research.

2.2 The Behavioural Resource-Based View (BRBV)

The theoretical mechanism connecting Entrepreneurial Resource Support to sustainability necessitates a re-evaluation of the traditional Resource-Based View (RBV). Formulated by Wernerfelt and expanded by Barney, the standard RBV asserts that sustained competitive advantage is derived from internal resources that are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991; Wernerfelt, 1984).

However, in the context of subsidized agricultural development, critical resources such as high-yield grafted seedlings, chemical fertilizers, or access to localized cold storage are frequently commoditized and provided exogenously by development agencies. Under these conditions, the mere possession of a resource does not guarantee performance. This study advances a "Behavioural RBV" perspective, arguing that externally provided agricultural resources are latent.

A microfinance loan or a land-lease subsidy creates the potential for economic expansion, but realizing that potential entails significant uncertainty. It requires an active entrepreneurial agent who possesses the risk-taking propensity to deploy borrowed capital, the innovativeness to optimize novel inputs, and the proactiveness to rapidly restructure their farm operations. Without these psychological traits, the provided resources may be misallocated or left entirely unexploited. Consequently, it was utilized in hypothesizing that the impact of resource provision on farm sustainability is heavily mediated by the farmer's EO.

2.3 Social Network Theory and Network Mobilization

Entrepreneurial Networking Support was anchored in Social Network Theory, which traditionally emphasizes the competitive advantages inherent in structural ties, weak linkages, and the bridging of structural holes (Nohria & Eccles, 1992). For smallholder farmers, escaping the gravity of localized, low-margin markets requires accessing non-redundant information regarding export compliance, premium pricing structures, and advanced value-addition technologies.

NGOs frequently attempt to artificially engineer these network structures by organizing farmer cooperatives or facilitating visitations by multinational juice processors. However, a purely structuralist perspective is insufficient. The study draws a critical distinction between network access and network mobilization. Introducing a smallholder farmer to a commercial exporter grants access, but executing a binding forward contract, adhering to stringent phytosanitary delivery schedules, and negotiating equitable terms require profound entrepreneurial agency. A highly proactive farmer leverages the NGO-facilitated introduction to bypass local brokers entirely, while a risk-averse farmer may attend the networking event but default back to traditional, low-risk subsistence sales. Therefore, this study hypothesizes that the efficacy of network interventions is heavily contingent upon the mediating mechanism of the farmer's entrepreneurial orientation.

2.4 Technical and Skills Support

In sharp contrast to the utilization of capital resources and the navigation of complex commercial networks, technical and basic skills support operate under fundamentally different mechanics. Technical interventions such as agronomic training on pruning, the installation of biological pheromone traps for the mango fruit fly, or post-harvest handling methodologies function as absolute operational hygiene factors.

Acquiring the specific technical knowledge to eradicate a localized pest infestation yields immediate, tangible improvements in crop viability and directly curtails the misuse of hazardous pesticides. Executing these technical protocols requires baseline compliance and competence, rather than high-level entrepreneurial risk-taking or market aggression. Therefore, it is theorized that technical and skills-based interventions bypass the psychological bottlenecks of EO, exerting a direct, universal effect on sustainable production regardless of a farmer's inherent behavioural posture.

2.5 Triple Bottom Line (TBL) Sustainability

In the contemporary era of agricultural development, evaluating farm performance solely through the unidimensional lens of economic yield is fundamentally inadequate. The global transition toward the SDGs necessitates a holistic measurement paradigm. Consequently, this study operationalizes the dependent variable sustainable smallholder mango production through Elkington's Triple Bottom Line (TBL) framework (Elkington, 1997).

A sustainable agripreneurial venture must concurrently satisfy three dimensions:

1. **Economic Sustainability:** Ensuring long-term profitability, yield stability, and tangible improvements in household wealth and asset accumulation.
2. **Social Sustainability:** Fostering community resilience, achieving localized food security, and crucially, ensuring the active inclusion and equitable profit-sharing of marginalized demographics, notably women and youth, in operational decision-making.
3. **Environmental Sustainability:** Mitigating the ecological footprint of intensification through the adoption of Integrated Pest Management (IPM), biodiversity preservation, soil health maintenance via organic composting, and the efficient utilization of agricultural waste.

III. RESEARCH METHODOLOGY

3.1 Philosophical Paradigm and Research Design

To comprehensively interrogate the complex interplay between observable structural interventions and the subjective psychological realities of the farmers, this research was anchored in a pragmatism philosophical paradigm. Pragmatism provides a double-face epistemological rationale, acknowledging the existence of an objective reality while simultaneously valuing the multiple, socially constructed interpretations of that reality by the individual actors. Consequently, the study employed a convergent parallel mixed-methods, cross-sectional survey design. This design facilitates the simultaneous collection of diverse, multi-dimensional data, capturing a definitive snapshot of the population to evaluate the causal pathways between the dependent, independent, and mediating variables at a specific point in time.

3.2 Study Population and Sampling Design

The study was conducted in Makueni County, Kenya. The target population consisted of the estimated 28,696 smallholder farmers actively engaged in the mango value chain within the county. Following the Food and Agriculture Organization (FAO) classification, smallholders were strictly defined as farming households

operating on three acres of land or less (FAO, 2015). Within this broader population, an accessible sub-population of 7,345 farmers operating within organized common interest groups across the highest-density production zones was identified.

To determine the appropriate sample size, Cochran's formula was applied (Cochran, 1963), yielding a baseline requirement of 384 respondents, assuming a 95% confidence level and a 0.05 margin of error. To buffer against unit non-response and ensure robust statistical power, the target sample was expanded by 20 percent to 460 farmers.

A rigorous four-stage, multi-stage stratified random sampling technique was employed to identify the final respondents:

1. **Stage 1 (Sub-County Level):** The Kaiti and Makueni sub-counties were purposively selected due to their overwhelming dominance in commercial mango cultivation.
2. **Stage 2 (Ward Level):** Within these sub-counties, four specific wards (Ukia, Kee, Wote, and Nzaui/Kilili/Kalamba) were purposively selected based on production density and the historical concentration of NGO interventions.
3. **Stage 3 (Sub-Location Level):** Ten sub-locations were selected using a simple random pick methodology including Utaati, Kyuasini, Mukuyuni, Nziu, Kalamba which are key in mango farming subsector in Makueni County.
4. **Stage 4 (Household Level):** Utilizing registries maintained by ward agricultural officers and farmer cooperative leaders, individual farming household heads were randomly drawn from the aggregated pools within the selected sub-locations.

3.3 Response Rate

Following the administration of the survey and rigorous data cleaning, 366 fully completed and usable questionnaires were retained, representing a highly satisfactory effective response rate of 85.43%.

3.4 Data Collection Instruments

Primary data was harvested utilizing a comprehensive, structured questionnaire administered directly to the household heads by trained enumerators to ensure high comprehension and response rate. The instrument was structured into four sections:

1. **Demographics and Farm Characteristics:** Capturing data on age, gender, educational attainment, land acreage, tree cultivars (indigenous versus grafted), and gross income trajectories.
2. **Agripreneurship Interventions (Independent Variables):** Evaluated utilizing a 5-point Likert scale (ranging from 1 = Strongly Disagree to 5 = Strongly Agree). The constructs were measured across 69 specific items covering Entrepreneurial Skills (21 items), Resource Support (19 items), Networking (14 items), and Technical Assistance (16 items).
3. **Entrepreneurial Orientation (Mediator):** Measured across 28 behavioural statements assessing the farmer's innovativeness, proactiveness, and risk-taking capacity, adapted from Miller's foundational dimensions (Miller, 1983).
4. **Production Sustainability (Dependent Variable):** Evaluated across 25 items designed to capture the three TBL dimensions: economic resilience, social inclusion (specifically regarding women and youth), and environmental stewardship.

3.5 Instrument Validity and Reliability

To ensure internal consistency and reliability, the instrument was subjected to a pilot study among 38 out-of-sample farmers. The subsequent reliability analysis yielded an overall Cronbach's Alpha of 0.832, substantially exceeding the widely accepted 0.70 threshold for social science research. Face and content validity were rigorously verified by domain experts.

3.6 Data Analysis Methods

Quantitative data was processed and analysed using SPSS version 21. The data was systematically screened for monotonicity and anomalies, missing values which constituted less than 0.78% of the dataset were resolved through mean substitution. Multivariate outliers were identified and evaluated using the Mahalanobis distance parameters.

The primary data analysis was executed in three distinct phases:

1. **Descriptive Analysis:** Elucidating the demographic contours and central tendencies including means, standard deviations, skewness, and kurtosis of the agricultural population.
2. **Principal Component Analysis (PCA):** A dimensionality reduction technique conducted by utilizing orthogonal Varimax rotation with Kaiser Normalization to validate the construct measurements and extract the most statistically reliable underlying factors.

3. **Mediation Analysis using OLS Regression:** The study hypothesis testing was executed utilizing Ordinary Least Squares (OLS) regression through the PROCESS Macro (Model 4) developed by Hayes (Hayes, 2018). This robust macro estimates the direct effect (the impact of X on Y, independent of the mediator) and the indirect effect (the specific quantum of impact transmitted from X to Y *through* the mediator, M). The statistical significance of the mediating effects was ascertained using 95% bootstrap confidence intervals (BootCI) generated from 5,000 bootstrap samples. Mediation was definitively confirmed if the resulting confidence intervals excluded zero.

IV. FINDINGS

4.1 Descriptive Statistics

4.1.1 Smallholder Farmer Demographic and Farm Characteristics

The demographic profile of the respondents uncovered the deeply entrenched socio-cultural dynamics governing land ownership and agricultural decision-making in the ASAL regions. The findings revealed that sector was predominantly male-led, with men constituting 72.7% of the household heads, compared to 27.0% women. The farming population comprised of a demographic, averaging 50.2 years of age. Crucially, the educational attainment within this rural mango farming subsector was relatively robust; 38.0% of the farmers had completed secondary education (KCSE), 29.2% held primary certification (KCPE), and a significant 22.9% possessed post-secondary diplomas or university degrees. Analysis of variance (ANOVA) revealed that farmers possessing higher educational credentials demonstrate significantly higher levels of Entrepreneurial Orientation ($F = 2.04$, $p < 0.1$), suggesting that formal education fundamentally enhanced the farmer the psychological capacity for innovativeness and risk assessment.

The operational parameters confirmed the smallholder classification of the participants based on FAO criteria. The average farm dedicated 2.17 acres specifically to mango cultivation, heavily integrated with 2.83 acres utilized for alternative crops and pasture. The commercial transition of the sector is starkly evident in cultivar adoption, the average household planted 82.8 improved, grafted mango trees, compared to a mere 5.4 indigenous trees. The mango farming operation activities were overwhelmingly reliant on family labor, with 64.5% of the farms operating without a single external employee.

Despite the high density of high-yielding grafted trees, the farmer economic realization remained alarmingly modest. Approximately 85% of the farmers reported gross annual sales from mangoes below Ksh 100,000 (roughly $750 USD), and 30.9% of the surveyed households lived below the absolute poverty line of $1.90 per day. However, a strong positive correlation was observed between the number of grafted trees and the gross household income, validating the crop's potential as an engine for poverty alleviation.

Table 1: Farmer Demographic and Farm Characteristics

Characteristic	Category	Frequency	Percentage	Mean
Gender	Male	266	72.7%	-
	Female	99	27.0%	-
Education Level	KCSE (Secondary)	139	38.0%	-
	KCPE (Primary)	107	29.2%	-
	Diploma/Degree	84	22.9%	-
Farm Size (Mangoes)	Acres	-	-	2.17
Cultivars	Grafted Trees	-	-	82.80
	Indigenous Trees	-	-	5.37

4.1.2 Descriptive Statistics of the Independent Variables

An analysis of the specific interventions received by the farmers provided a clear picture of the programmatic priorities of development agencies operating in Makueni County. Out of the 366 respondents, 146 (39.9%) confirmed active participation in formal agripreneurship support programs, highlighting a significant coverage gap within the county.

Regarding Entrepreneurial Skills Support, interventions were heavily skewed toward technical agronomy. Technical training on pesticide spraying (Mean = 4.58), fertilizer application (Mean = 4.43), and post-harvest handling (Mean = 4.23) scored significantly higher than core entrepreneurial skills, such as business planning (Mean = 3.82) or opportunity recognition (Mean = 3.94). This indicates a systemic preference by NGOs to prioritize immediate yield protection over long-term commercial acumen.

For Entrepreneurial Resource Support, programs prioritized human labour assistance (Mean = 3.64) such as facilitating access to agronomists and trained service providers over hard capital provision (Mean = 3.17). Support for structural land acquisition and tenure security ranked lowest (Mean = 2.55). On Entrepreneurial Networking Support, development agencies demonstrated a clear bias toward upstream supply linkages (Mean = 3.29), connecting farmers with agro-vets and microfinance institutions, while performing poorly in linking farmers to lucrative downstream markets (Mean = 3.11), particularly international exporters

(Mean = 2.36) and localized processors (Mean = 2.88).

4.1.3 Descriptive Statistics of the Mediating Variable

Analysis of the mediator variable, Entrepreneurial Orientation (EO), revealed robust intrinsic mindsets among the farmers. The respondents scored exceptionally high on Proactiveness (e.g., "constantly looking for new ways to improve my life", Mean = 4.62) and Innovativeness (e.g., "challenged by unresolved problems", Mean = 4.52). Interestingly, an independent sample t-test revealed that farmers who received external support reported significantly higher levels of Innovativeness ($p < 0.000$) and Risk-Taking ($p = 0.007$) compared to unassisted farmers. However, unassisted farmers reported significantly higher levels of Proactiveness ($p < 0.000$), suggesting that sheer survival necessity drives immense self-motivation among those excluded from formal aid networks.

4.1.4 Descriptive Statistics of the Dependent Variable

Analysis of the study dependent variable TBL Sustainability revealed that farmers reported high confidence in the environmental sustainability of their operations, strongly agreeing that their chemical usage does not harm localized biodiversity (Mean = 4.50). Economically, farmers rely on mangoes primarily for sustenance (Mean = 3.79) and school fees (Mean = 3.62), but rarely generate sufficient margins for major capital asset acquisition. Social sustainability scored lowest, particularly regarding the formal inclusion of women and youth in asset ownership and financial autonomy. Crucially, an independent t-test proved that farmers receiving agripreneurship support reported statistically significantly higher scores across all three dimensions of sustainability (Economic, Social, and Environmental; all $p < 0.000$) compared to farmers who never received any form assistance from development agencies.

4.2 Diagnostic Tests and Principal Component Analysis (PCA)

Prior to conducting the regression analysis, the measurement constructs were subjected to Principal Component Analysis (PCA) to validate their underlying structures.

1. **Agripreneurship Support Programs:** The PCA yielded a Kaiser-Meyer-Olkin (KMO) measure of 0.912 and a highly significant Bartlett's Test of Sphericity ($p < 0.000$). The Varimax rotation successfully extracted six distinct components accounting for 77.07% of the total variance, refining the variables into highly reliable indices for Networking, Skills, Resources, Technical Training, Specialized Support, and Informational Support, the latter three merged into the broader Technical Support variable for regression.
2. **Entrepreneurial Orientation:** The KMO stood at 0.903 ($p < 0.000$), successfully and distinctly extracting the three classical dimensions of Innovativeness, Proactiveness, and Risk-Taking.
3. **Mango Production Sustainability:** The KMO was 0.915 ($p < 0.000$), with the extraction perfectly mirroring the hypothesized TBL framework by isolating Economic, Social, and Environmental components.

Subsequent diagnostic testing confirmed the suitability of the data for OLS regression. Bivariate scatter plots and Pearson's r correlations confirmed linear relationships between all predictors and the dependent variable. Multicollinearity was ruled out, as the Variance Inflation Factors (VIF) for all predictors were substantially below the threshold of 5, ranging from 3.004 to 4.258. Serial autocorrelation was absent, evidenced by a Durbin-Watson statistic of 1.517. While Levene's test indicated the presence of heteroscedasticity, this minor violation of assumptions was comprehensively mitigated by the PROCESS Macro, which utilizes heteroscedasticity-consistent covariance estimators (HC0) to ensure the unwavering validity of the subsequent statistical inferences.

4.3 Hypothesis Testing and Regression Analysis

The main objective of this research was to analyse the direct effects of the interventions on sustainability (H_1-H_4) and the indirect, mediating effects of the farmer's entrepreneurial orientation (H_{5a}-H_{5d}). The variables were subjected to process analysis using the simple mediation Model 4 at 95% bootstrap confidence intervals, utilizing 5,000 bootstrap samples.

4.3.1 Direct Effects Analysis (H_1 - H_4)

The "Total Effect" model within the PROCESS output measures the combined impact of the independent variable on the dependent variable, establishing the baseline efficacy of the interventions prior to isolating the mediator.

Table 2: Summary of Total and Direct Effects on Mango Production Sustainability

Antecedent Variable (X)	Total Effect (c)	Standard Error	t-value	p-value	95% LLCI	95% ULCI	Decision
Skills Support (X1)	0.3709	0.0244	15.2254	< 0.000	0.3230	0.4188	H1 Supported
Resource Support (X2)	0.4091	0.0299	13.6719	< 0.000	0.3503	0.4680	H2 Supported
Networking Support (X3)	0.4787	0.0194	24.6196	< 0.000	0.4404	0.5169	H3 Supported
Technical Support (X4)	0.3898	0.0207	18.8602	< 0.000	0.3492	0.4305	H4 Supported

The findings conclusively demonstrated that all four dimensions of agripreneurship interventions wield a highly significant, positive direct effect on the sustainability of the smallholder mango farms.

H_1 (Skills Support): The total effect of entrepreneurship skills training was $c = 0.3709$ ($p < 0.000$), accounting for 36.01% of the variance in production sustainability. Thus, H_1 is strongly supported.

H_2 (Resource Support): The provision of capital, land security, and labour yielded a total effect of $c = 0.4091$ ($p < 0.000$), validating H_2.

H_3 (Networking Support): Networking interventions exerted the most profound overall influence on the farms, generating a total effect of $c = 0.4787$ ($p < 0.000$). A unit increase in market and supplier linkages translates to nearly a half-unit increase in TBL sustainability. Hence H_3 was fully supported.

H_4 (Technical Support): Access to extension services and informational research yielded a total effect of $c = 0.3898$ ($p < 0.000$), supporting H_4.

4.3.2 Mediation Analysis: The Indirect Effects of Entrepreneurial Orientation (H_{5a} - H_{5d})

While the interventions are universally effective at a baseline level, the primary theoretical inquiry of this study evaluates whether these physical and structural interventions are amplified by the psychological state of the farmer. This is quantified by the indirect effect (ab), which measures the exact quantum of impact transmitted from the intervention (X) to sustainability (Y) specifically *through* the enhancement or activation of the farmer's EO (M).

Table 3: Mediation Analysis of Indirect Effects via Entrepreneurial Orientation

Mediated Path (X → M → Y)	Indirect Effect (ab)	Boot SE	Boot LLCI	Boot ULCI	Mediation Status
Skills (X1) → EO → Sustain (Y)	0.0194	0.0100	-0.0006	0.0386	Non-Significant (Reject H5a)
Resources (X2) → EO → Sustain (Y)	0.0391	0.0103	0.0191	0.0592	**Significant (Support H5b)**
Networks (X3) → EO → Sustain (Y)	0.0338	0.0097	0.0142	0.0524	**Significant (Support H5c)**
Technical (X4) → EO → Sustain (Y)	0.0150	0.0105	-0.0059	0.0357	Non-Significant (Reject H5d)

4.4 Interpretation of the Findings

4.4.1 The Non-Mediation of Skills and Technical Support

In analysing the pathway for Entrepreneurship Skills Support (X1), the specific indirect effect routed through EO was calculated at ab = 0.0194. However, the crucial 95% bootstrap confidence interval ranged from -0.0006 to 0.0386. Because this interval spans across zero, the indirect effect was not statistically distinguishable from zero. Consequently, Entrepreneurial Orientation does *not* significantly mediate the relationship between skills support and farm sustainability, leading to the rejection of H_{5a}.

A nearly identical statistical reality emerged in Entrepreneurial Technical Support (X4). The indirect effect generated through the EO mediator was ab = 0.0150. The bootstrap confidence interval (-0.0059 to 0.0357) again explicitly included zero, rendering the mediation effect statistically insignificant. H_{5d} was therefore rejected.

4.4.2 The Mediation Effect of Resources and Networks

In stark contrast, the structural and capital-intensive interventions presented a profoundly different relationship. For Entrepreneurial Resource Support (X2), the indirect effect on sustainability mediated specifically by EO was ab = 0.0391. The 95% bootstrap confidence interval tightly brackets a purely positive range (0.0191 to 0.0592), successfully excluding zero. This provided a definitive empirical validation for H_{5b}. To quantify the magnitude, the ratio of the indirect effect to the total effect ($P_M = 0.0391/0.4091$) indicates that 9.56% of the total benefit derived from resource provision was intrinsically transmitted through the activation of the farmer's entrepreneurial mindset.

Similarly, Entrepreneurial Networking Support (X3) exhibited a highly significant indirect effect through the EO mediator, recorded at ab = 0.0338. The bootstrap confidence interval (0.0142 to 0.0524) confirmed the robust statistical significance of this mediation pathway, fully supporting H_{5c}. The analysis estimated that 7.60% of the total holistic benefit generated by networking interventions was powered by the farmer's proactive and innovative orientation.

4.5 Discussion

The empirical findings of this study offer a paradigm-shifting perspective on the mechanics of agricultural development within emerging economies. By dismantling the "black box" of intervention efficacy, the analysis fundamentally proves that not all developmental support interacts with the psychology of the beneficiary in the same manner.

4.5.1 Validating the Behavioural Resource-Based View

The decisive confirmation of Hypothesis 5b provides empirical bedrock for the Behavioural Resource-Based View within rural agrarian ecosystems. Standard economic models routinely assume that injecting capital, high-yield inputs, or advanced physical infrastructure into a low-income community will automatically and uniformly elevate output. The data from Makueni County refutes this monolithic assumption.

The finding that EO is an indispensable mediator for resource efficacy demonstrates that physical assets in agriculture are functionally latent. When the County Government of Makueni or an international NGO disburses a subsidized loan or a grant for water harvesting equipment, they are introducing capital risk and operational uncertainty into a fragile household economy. Navigating this uncertainty to generate a sustainable yield requires a psychological agent possessing high levels of innovativeness and a deep tolerance for risk-taking. If an identical microfinance facility is granted to two farmers, the farmer exhibiting a superior entrepreneurial orientation will inherently deploy that capital more aggressively investing in certified biological pest controls or expanding acreage thereby maximizing economic and environmental returns. Thus, resource support programs are structurally contingent upon the mindset of the recipient.

4.5.2 The Dynamics of Network Exploitation

A mirrored behavioural reality governs the realm of market and supplier linkages. Traditional Social Network Theory frequently limits its focus to the structural advantages of connectivity assuming that simply placing a smallholder farmer in contact with a multinational exporter resolves the market access dilemma.

The validation of Hypothesis 5c (EO significantly mediating networking support) proves that network structures must be actively and aggressively exploited to impact the Triple Bottom Line. Connecting a rural farmer in the Kee ward to an international juice processor provides structural access, but maintaining that commercial relationship requires a profound degree of entrepreneurial agency. A proactive farmer leverages this artificially facilitated network to permanently bypass exploitative local brokers, negotiate premium advance pricing, and secure quality certifications. Conversely, a risk-averse farmer, despite possessing the same structural contact, may fail to execute a forward contract out of fear of stringent phytosanitary rejection rates. Consequently, agricultural networks engineered by development agencies are merely potential energy, the farmer’s EO acts as the kinetic force that translates that access into sustainable, multi-dimensional wealth.

4.5.3 The Universal Efficacy of Technical and Skills Interventions

The most potent insight for systemic programmatic redesign originates from the negative findings regarding H_{5a} and H_{5d}. The statistical evidence definitively established that a farmer's entrepreneurial mindset does not mediate or restrict the impact of core skills training or localized technical extension services.

In the ASALs of Makueni, combating severe phytosanitary threats like the mango fruit fly which has historically crippled the county's export viability requires precise, standardized agronomic execution. Learning the exact spatial requirements for deploying a pheromone trap, understanding the chemical dilution rates for safe pesticide application, or mastering the specific grafting techniques for high-yield cultivars does not require a farmer to be a visionary innovator or an aggressive risk-taker. These technical competencies function as absolute agricultural hygiene factors.

Once an extension officer imparts this technical knowledge, a farmer can execute it through simple, rote compliance. Doing so yields an immediate, universal reduction in post-harvest losses and curtails environmental degradation, regardless of whether the farmer's psychological profile is highly conservative or boldly entrepreneurial. This creates a vital divergence in the anatomy of agricultural aid: while complex commercial interventions (such capital injection or export networking) are bottlenecked by the recipient's psychological willingness to adopt risk, basic agronomic education bypasses behavioural barriers entirely, making it the most universally reliable mechanism for establishing baseline sustainability across a rural population.

V. CONCLUSIONS

This paper presents a comprehensive analysis that systematically dismantles the monolithic approach to agricultural development by mapping the exact mediating mechanics of Entrepreneurial Orientation across the mango value chains of Makueni County. The evidence unequivocally confirms that while all facets of an Entrepreneurship Development System; skills, resources, networks, and technical support directly elevate the economic, social, and environmental sustainability of smallholder farms, the operational pathways governing their success differ profoundly.

The transition to sustainable agripreneurship is not merely a function of exogenous resource distribution; it is a complex interplay between engineered structural support and the intrinsic cognitive agency of the farmer. Capital resources and formal market networks are fundamentally latent assets that absolutely require the innovativeness, proactiveness, and risk tolerance of the operator to be activated and translated into sustainable outcomes. Conversely, technical agronomic training fortifies the farm's environmental and economic resilience universally, bypassing the necessity for an entrepreneurial mindset.

VI. POLICY AND PROGRAMMATIC RECOMMENDATIONS

This study presents statistically validated behavioural insights offering a highly actionable, bifurcated strategic framework for Governments and international development institutions seeking to transition smallholders out of the cycle of poverty and subsistence:

1. **Strategic Beneficiary Segmentation and EO Screening:** Development agencies, microfinance institutions, and county departments must immediately abandon homogeneous targeting and universal aid distribution models. Because capital-intensive resources and high-level market linkages only yield optimal returns on investment when paired with a proactive mindset, institutions should implement formalized EO psychometric screening during the vetting process. Growth-oriented capital such as infrastructure grants for cold storage or subsidized inclusion in commercial contracts must be systematically directed exclusively toward farmers demonstrating high baseline EO scores. This protocol ensures that scarce, high-value financial resources are allocated to operators who possess the inherent behavioural mechanics required to multiply them.
2. **Universal Technical Safety Nets:** Conversely, to protect the broader base of low-EO, subsistence-oriented farmers who would be overwhelmed by commercial debt, governments and NGOs must heavily prioritize universal Technical and Skills Support. Expanding robust extension services such as the mandatory technical training accompanying the establishment of pest-free areas e.g., Fruit Fly Free Zones would universally guarantee baseline food security, ecological protection, and poverty alleviation without demanding unrealistic or unsustainable behavioural shifts from risk-averse demographics.
3. **Entrepreneurial Mindset Integration in Extension Curricula:** To progressively graduate low-EO farmers into the ranks of commercial agripreneurs, standardized agricultural extension curricula should be fundamentally re-engineered. Field officers must transition from acting purely as agronomic advisors to functioning as holistic "Farm Business Advisors." By actively integrating psychological empowerment modules focusing intensely on opportunity recognition, financial risk management, and competitive proactiveness into routine agricultural education, stakeholders can artificially incubate the entrepreneurial orientation required for farmers to eventually absorb and successfully exploit advanced capital and network support.

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