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The Role of Social Networks in Community Development among Smallholder Farmers in Western Kenya

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ABSTRACT

Developing rural communities remains a critical challenge in developing countries, where smallholder agriculture is the main source of rural livelihood, particularly in strengthening food security. However, reliance on agriculture alone has often failed to provide the requisite economic resources to fortify rural economies. This study introduces a novel perspective by exploring alternative social network factors beyond agriculture that contribute to community development in Western Kenya. Utilizing a mixed-methods sequential design, a survey questionnaire was administered to a random sample of 245 rural households engaged in both on- and off-farm activities, followed by four purposively selected focus group discussions (FGDs) comprising 28 participants. A binary logistic regression model was employed to analyze quantitative data, identifying age ($p = .07$), education ($p = .10$), and off-farm income ($p = .08$) as significant predictors of community development. The qualitative phase employed thematic analysis of FGDs to capture subjective farmer perspectives on alternative development sources. Findings reveal that engagement in off-farm activities, often overlooked in rural development discourse, plays a pivotal role in fostering community growth. This dual-method approach provides comprehensive insights into the socio-demographic drivers of development, emphasizing the interplay between quantitative metrics and qualitative narratives. The study provides an integrative analysis of the role of social networks and off-farm activities as catalysts innovates by offering new pathways for policy interventions that sustainable community growth in rural agricultural communities.

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1. Introduction

An increasing number of local communities or locally based agricultural entrepreneurs play a critical role in the development of the communities they serve. These communities often outsource information, services, and products from the community and beyond. The outsourced services allow citizens to benefit from the free dissemination and exchange of information, services, and products. Social networks are a ubiquitous feature of developing economies. A salient feature of these networks is to support business activity [1]. In practice, agriculture is a social and cultural phenomenon which converges with agricultural and non-agricultural communities for the procurement of different mutually beneficial services. Given the importance and social nature of agriculture in people's lives, it is not surprising that communities serve as a foundation on which experiences, knowledge, products, and ideas are shared and reflected upon.

Given the social nature of agriculture, social networks are important in regulating community activities and interactions, which in turn establish the pathways to community infrastructural growth and development. If used optimally, they enhance the potential of knowledge expansion and sharing among various network actors. A social network consists of a finite set of actors and their relations define the network's web information, knowledge, and product sharing across the various actors [2]. The web of networks that link individuals and groups in a community are key in the identification and measurement of social connectedness which links the various network nodes and how the various patterns exhibit inclusionary and exclusionary tendencies between the network web [3]. In the use and acquisition of resources, communities consist of various social networks facilitating the overall wellbeing of individuals and groups. Agricultural information shared between various sources of products and services permits farmers to identify information points where they can access those agricultural implements.

In developing countries, particularly in the Sub-Saharan African (SSA) region, the smallholder farming sub-sector dominates the agricultural sector [4]. In many African countries, small scale agriculture contributes decisively to the gross domestic product (GDP), overall food security, and in strengthening rural livelihoods among households [5]. The general outlook for agriculture in the region is situated in the context of several mega-trends that shape the sector's growth and development. The main trends include rapid population growth, urbanization, and associated transformation from farm to non-farm employment [6]. Due to these factors, the sub-sector generally struggles with persistent stagnation in crop productivity, lack of the requisite technology, and insufficient structural and sectoral policies that stifle the sector's growth potential. Such challenges render small farmers to rely on groups and the associated social networks as resources for their sustenance [7].

Social networks encompass the engagement of groups of people with diverse interests who are associated with and build relationships through shared community interests [8]. The social network tools that foster these interactions are intended, by default or by design, to mutually benefit the engaged groups through the sharing of information or ideas critical in the transmission of information in real-time and reaching a wider audience that is otherwise not possible in its absence. In rural communities, agricultural households rely on these networks to enhance the expansion of their activities and use the different nodes to source the information and input necessary in their farming activities. Therefore, these viable social networks strengthen the role of the smallholder sub-sector in rural household food security [9].

Across the agricultural sector, social networks enable larger segments of the agricultural communities in developing nations to access pertinent agricultural information, services, and products that support agricultural production among farmers. The recent digital development wave has increased the simultaneity of information sharing between a variety of agricultural community actors and groups in many developing countries [10]. For instance, the use of mobile technology by many smallholder farming households has facilitated the sharing of agricultural information via digital technologies. Besides those agricultural productivity gains, mobile technology enables farmers and associated groups to increase chances for digital development and potentially reduces information asymmetry in agricultural markets.

As the social network fabric becomes strengthened through the proliferation of digital technology, the speed of information sharing between different nodes, as well as the intensity of social network nodes, all become more amplified. However, the tendency of individuals and groups to associate with one another creates difficulties in measuring the relative role of strong and weak ties in information sharing [11]. Network ties between various actors have increasingly become blurred due to the multiplicity of ties.

Agriculture has long played a pivotal role in rural growth and development, which in turn strengthens the quality of rural livelihoods through agricultural incomes. Agricultural growth translates to improved rural incomes and reduced food insecurity among households that rely on agriculture for their livelihoods [12]. In recent years, the decline in agricultural productivity has adversely impacted on the overall economic well-being of many rural households. Dependence on the agricultural sector as the sole means of sustaining rural communities calls for the consideration of alternative economic channels of sustaining rural livelihoods. In the literature, social network channels have not been fully exploited as avenues for enriching rural communities. Some of those channels include those that support community development through other means besides agriculture.

Social networks are a key determinant of, for instance, infrastructure improvement. Such networks have the potential to create alternative channels of local development besides the agricultural sector. Social networks may also hinder agricultural development, which remains a key sector that rural livelihoods depend on. There are several social network factors that have not been adequately researched to determine their role in promoting community participation and engagement in alternative channels for improving rural development. The unexplored factors include farmer-to-farmer extension, participation in local community social networks, and access to public and private extension by households in the rural communities. Access to agricultural extension provides farmers with networks that interact with stakeholders of interest with rural development.

The study will analyze the contribution of social networks and socio-economic variables that explain household participation in social activities. The study will focus on social network channels that are critical in the development of smallholder rural farming household communities of western Kenya. Studies have shown that the role of agriculture in enhancing the economic wellbeing of communities in Kenya has declined in the last few years due to falling agricultural productivity, a rapid growth in the population and limited use of modern production practices. First, the study contextualizes the characteristics of smallholder farmers in the region and would provide an important basis for analyzing the role of social networks in facilitating community development. Second, the research evaluates alternative ways of driving community development in Kakamega County, Kenya. Group participation in community development remains an exception rather than the rule when it comes to community development. The rest of the study is organized as follows. The next section provides a review of the literature, the theoretical framework, conceptual framework, methodology, results, and discussion. Finally, the study provides a conclusion, implications, and future research.

2. Literature Review

To understand how social networks affect community development, one needs to identify the key characteristics that differentiate them. To begin with, the pattern of network links will differ according to the type of relations involved between a variety of actors. Thus, these structural network characteristics and the effects they bring to bear on the social processes such as information sharing, knowledge transfer, consensus building, and power relations are important [13, 14]. This affirms the role that social networks play as a common denominator when different stakeholders come together to effectively deal with problems that threaten their common good. Social networks turn out to be more important than the existence of formal institutions built with the aim of dealing with social challenges [15]. The content of the relational ties between the different actors tends to vary across networks. For instance, the ties of a network of close kin will most likely be different from that of a work colleague [8]. Similarly, the ties between a household and an extension agent would be different from the relational tie between government agents and input commercial suppliers. Therefore, in studying social networks it is important to specify the relations studied and how they relate to overall community development [16].

In community development, whether it is educating people on how to be responsible environmental stewards or improving the physical infrastructure, the density of the social ties determines the strength of the interaction

which will eventually lead to the realization of the intended goal. Thus, a reasonably starting hypothesis would be that the more social ties, the more the possibilities for joint action. Literature supports the evidence that social networks can improve the socio-economic well-being of communities because they form the backbone of social and economic life [17]. Economic opportunities can arise from the contacts established outside of a tightly knit community or group.

The fundamental framework of the social network theory is founded on inter-actor relationships. The various actors serve as the central focus of the network framework. Over its development, the theory has undergone gradual transformations which have informed the form and process. However, the core network perspective of the theory considers the web of relationships in which various actors are embedded [18]. There is a large pool of research that confirms that a diverse set of traditions have shaped the social network theory [19]. The theory's early development followed three streams of research traditions: sociometric analysis tradition, the interpersonal relations traditions, and an anthropological tradition. The theoretical framework did not evolve into a coherent framework until the 1960s after which the social network approach began to gain currency. As its name suggests, the key concepts that govern the network theory are centrality, cohesion, and structural equivalence. The theory is measured through relations – individual, group, or institutional. Each of these concepts are measured by the various nodes that define them.

Borgatti & Ofem [18] argue that in explaining organizational performance, a careful study of the characteristics of the organization plays an important role in predicting its relationship with other actors or groups. This equally applies to the behavior of individuals or other entities. While relationships are critical in defining a network, the nodes or actors and the corresponding ties that connect the nodes are also important. The strength of these ties determines the strength of the nodes. Considerations about what social relationships are, how they form and evolve, and how they connect to wider social layers are critical in the type of networks that exist [19]. Ties can be of a wide variety of types, such as friendships between individuals, communication patterns between two or more groups, or linkages between industries. This social relation can also apply in farming communities whereby individuals or groups of individuals are constantly interacting. The interactions are driven by the differing social needs of the community members. Farmers may need agricultural inputs to use in their farm and that can be obtained from dealers located outside of the community. On the other hand, dealers require farmers who might be interested in purchasing agricultural inputs. The two nodes may be connected through agricultural extension agents or an agricultural communication channel. The strength of the linking agents will determine the efficacy of this channel.

Low-income households in developing countries earn incomes that are low, irregular and unpredictable [20]. These income trends make frequent small transactions more important than rare for many of these struggling households [21, 22]. These farm households rely on a variety of social networks (Facebook, LinkedIn, media sharing tools (YouTube) and wikis) in communicating with their peers [23]. These networks have become prevalent modes of information sharing among low-income households. A few of these communication channels have replaced the traditional information sharing through extension agents [24]. Most households still rely on agricultural extension as traditional information dissemination.

2.1. Study Area

The study was conducted in Kakamega County, one of the 47 counties of Kenya located in the western region of Kenya. Kakamega County has a land area of about 1,171 mi^2 and it is located on the Equator where average temperatures range between 66.74°F in July and 70.34°F in February [25], and high precipitation typically over 78.74 inches per year. The area is characterized by mixed small-scale agriculture and widespread low agricultural productivity [26]. The resulting low production and meager incomes contribute to the prevalent poverty and food insecurity among the rural smallholder agricultural households. However, the area is endowed with rich soil and ample rainfall due to its location on the Equator. There are two main ecological zones in Kakamega County; the upper-medium (UM) and the lower medium (LM) zones. The two zones possess different soil fertility features and different crop yields [26, 27].

This study was conducted in the upper-medium ecological zone which included the central and southern parts of the county. The seven sub-counties covered in the study were: Malava, Shinyalu, Mumias East (Shianda), Ikolomani, Khwisero, Lurambi, and Butere. Subsistence farming is predominant in these sub-counties. Farm produce harvested by households is mostly consumed within the household and any surplus sold in neighboring markets and sold to allow those farmers to obtain products unavailable on-farm. Small farm sizes common in the area result in low crop productivity and sub-optimal output and prevalent food insecurity in the region.

3. Conceptual Framework

The study conceptualized social networks affecting smallholder farmers in rural communities of Kakamega where households are mainly relying on small scale agriculture while engaging in other off-farm activities. Among some of the off-farm activities referenced include supply of labor to neighboring communities, formal employment in surrounding urban areas and operation of small businesses. These activities supplement the food and income obtained from their farms.

Social network typology

4. Methodology

The study utilized primary data collected from 245 smallholder farmers drawn from seven of the twelve purposively selected sub-counties of Kakamega County, Kenya. The participants were randomly selected household heads and were all presumed to earn their living directly from agriculture or from remunerable activities off-farm. A questionnaire was administered among this sample in accordance with the objectives of the study. The questions were easy for the respondents to answer and provide the appropriate answer. The themes of the study are socio-economic characteristics of the respondents, and the social networks that govern the pertinent households. The first section relates to the first theme and deals with the socio-economic characteristics of the respondents, and the second section deals with the potential web of relationships in which these respondents were embedded. Thus, through the selected network variables, respondents were able to relate with other actors outside of their communities. Through those ties, those social networks would be brought to life.

Participation in community groups through the identified variables expanded household member networks and opened social networks that enhanced and promoted income generating opportunities, improved the health of the household members, provided leadership training opportunities for community members, hence it contributed to the overall development of the community. Agricultural service delivery sources are not located

within the communities where users reside, rather they are spread out outside of these communities. Agricultural practitioners often seek those services and inputs for their use by relying on various networks to access the input or service provided.

In this study, the socio-economic variables were defined based on the responses selected by the respondents in the survey questionnaire. The on-farm income variable was determined based on the quantity of the output they marketed calculated at prevailing prices. This variable is critical due to its importance in determining whether a household would seek supplementary income off-farm for sustenance of household members. Age is a common key variable when assessing the likelihood of engaging in a variety of activities, as well as the disposition to embrace certain agricultural practices. It is also assumed that younger farmers are more likely to be educated and would seek information about new technologies and practices for application in their farms than older farmers. The adoption of innovative applications in agriculture has become a current trend in agricultural development [28]. Younger farmers are more risk averse. They are more likely to attempt newer agricultural approaches due to their level of education and exposure.

The most prominent socio-economic variables are participation in other occupations, farmer-to-farmer networks, and access to extension. In this study, the respondents were asked to state if they engaged in off-farm income earning activities, participated in farmer-to-farmer networks, or sought and accessed extension services. These network variables linked the households with other sources of knowledge, income and in sustaining the livelihoods of community members.

4.1. Empirical Approach

The survey data collected through the questionnaire was analyzed by a logistic regression model in which community participation is expressed as a dependent variable capturing a household head's participation in social activities in the community. The predictor variables are defined as social network variables that influence social participation, such as farmer-to-farmer networks, access to agricultural extension, and household engagement in off-farmer income generating activities. In social network literature, these variables enhance social participation [29]. In other literature, membership in a local community groups or access to agricultural extension are channels for social participation [30]. The binary logistic regression model was represented as follows:

$$Prob(Y_i = 1) = P_i = F(Z_i) = F(\propto + \sum(\beta_i X_i) = \frac{1}{1+e^{-Z_i}} \quad (1)$$

In the foregoing specification, P_i represents the probability that a farmer participates in community social activity or not; X_i represents explanatory variables (factors presumed to determine a household head's decision to participate in community activity). The βs and αs are the parameter estimates.

$$Prob(Y_i = 0) = 1 - Prob(Y_i = 1) = (1 - P_i) = \frac{1}{1+e^{Z_i}} \quad (2)$$

From 1 and 2, we obtain

$$\frac{Prob(P_i=1)}{Prob(P_i=0)} = \frac{P_i}{1-P_i} = e^{Z_i} \quad (3)$$

In equation 3, P_i is the probability that Y_i takes the value 1, and $1 - P_i$ is the probability that Y_i takes the value 0, and e is the exponential constant.

According to Nyairo *et al*. [31], taking the natural log of both sides of equation 3, we get

$$Z_i = ln\left(\frac{P_i}{1-P_I}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + u_i. \quad (4)$$

where Xs represent the network variables that influence the household head's decision to be part of social participation and betas (βs) represent the impacts of the changes in the independent variable on the dependent variable. Similar econometric approach model has been used in estimating technology adoption [24, 32].

Specified empirical model

$$CP = \beta_1 LogInc + \beta_2 LogLS + \beta_3 Age + \beta_4 Age^2 + \beta_5 Gen + \beta_6 O_{Occ} + \beta_7 Ext + \beta_8 F2F + \epsilon \quad (5)$$

Equation Variables:

CP = Community participation

Log farm income = Farm income

Log land size = Land size

Age = Age of respondent

Age Squared

Gender= Gender of respondent

Off-farm Occupation = Alternative occupation outside of the farm

Access to Extension = Whether the household accessed extension

F2F = Farmer to Farmer networks

5. Results and Discussions

5.1. Socio-Economic Characteristics of Respondents in the Study Area

To have a better understanding of the respondents, a frequency distribution of the socio-economic characteristics was constructed to capture the characteristics of the sampled households. In Table **1**, the mean age of the household heads was found to be around 48 years of age. The average household size was about seven members per household, which was relatively high given the average household income. The implication of this was that most of the agricultural output was consumed in the household while a limited amount of it was marketed for income. The mean land size was about two acres per household and fetched $ 727 per year. The large household sizes can be presumed to be responsible for the low average annual earnings earned from marketed output. It is apparent that most of the output is consumed at the household level, considering the many mouths to feed per household.

In Table **1**, there is an evident variability in earned income from agricultural activities from the sampled households. The level of earnings corresponds to household land size owned by the households included in the study sample. There are a few outlier households with land sizes exceeding 20 acres. However, a majority of households operated farms with land sizes of less than five acres and these farm households relied upon off-farm sources of income to supplement their on-farm earnings. In many cases, and based on recorded income, the proportion of off-farm income exceeded on-farm income. This characteristic highlights the increasing share of off-farm income sources in supplement overall household income. From a labor perspective, the sharing of household labor was split between the various income sources for most households.

Table 1: Descriptive statistics (*n = 245*).

	Minimum	Maximum	Mean	Std. Deviation
Age	18	88	48.43	14.77
Household Size	1.00	16.00	6.93	2.85
State other occupation	1	99	59.31	46.76
Size of land in acres	.13	20.00	2.05	2.24
On-farm Income	$0.00	$18,377.26	$724.71	$1,547.63
Farmer-2-Farmer	0	9	5.77	4.15
Access to Extension	0	1	.36	.480
Valid N (listwise)				

The overview captured by descriptive statistics provides the socio-economic demographics of the communities under the study. The summary of network variables, as well as other socio-economic variables, identify the income levels, sources of income, and land size as the main variables. Sustaining rural community livelihoods depends on access to economic opportunities available to them.

Table 2: Socio-economic variables related to the households in the study area.

Variables	β	S.E.	Wald	df	Sig.	Exp(β)
Income (log)	0.036	0.362	0.010	1	0.921	1.04
Land Size (log)	-0.100	0.430	0.054	1	0.816	0.91
Age	-0.078	0.061	1.598	1	0.206	0.93
Age-Squared	0.001	0.001	1.927	1	0.165	1.00
Gender	-0.237	0.321	0.545	1	0.460	0.79
Other Occ	0.884	0.334	7.000	1	0.008***	2.42
Extension	8.375	3.859	4.709	1	0.030**	4377.48
Farmer-to-Farmer Network	0.838	0.455	3.395	1	0.065*	2.31
Constant	-7.672	4.476	2.938	1	0.087	0.00

Model Summary:
Cox & Snell R Square: 0.166
Nagelkerke R Square: 0.22
LR: 255.53

Table **2** provides a summary of the regression output of the variables that were regressed against community participation as captured in the binary logistic regression. The table contains the statistical significance (*p-values)* of the variables and the corresponding betas for those variables.

The logit analysis summarized in Table **2** shows three variables that are significant at 99%, 95%, and 90% levels of confidence. The model illustrates that controlling for other demographic variables, farmer participation in other off-farm occupation (.008), access to extension (.03), and participation in farmer-to-farmer networks (0,65) all suggested a relationship with a household member's participation in social activities. All three variables-maintained odds ratios that reflected significant odds ratios influencing social participation.

The variable access to agricultural extension indicates that household access to agricultural extension had the highest odds ratio (4337). This implies that those households that accessed agricultural extension were most likely to be actively engaged in community participation. The strength of this explanatory variable highlights how access to agricultural extension translates to household engagement in community activities. It can also be presumed that this directly contributes to positive improvement of households.

The incidence of participating in off-farm income generating activities was statistically significant (.008), at the 99% confidence level. This statistic indicates a strong relationship among the network variables. This suggests that working off-farm provides households with access to information, ideas, or services that are immediately unavailable to individuals in the community. These income generating activities offer an opportunity for households to access new information and ideas that benefit these farming households. Access to information, tools or new ideas is enhanced through available communication networks that households find at their disposal.

Household access to extension was statistically significant (0.03) at the 95% confidence level. The odds ratio of participating in social activities was 4337 times higher for a one unit increase in a household's access to extension. This finding suggests that accessing agricultural extension predicted the probability of the household head's choice of social activity participation. In literature, agricultural communication through extension agents and messages is a crucial source of access to essential agricultural services, knowledge, and ideas that can lead to positive community improvement such as improved agricultural management practices and better decision-making at the farm-level [33]. A study conducted in Northern Ghana to evaluate the determinants of access

agricultural extension services among rural women farmers concluded that socio-economic factors were statistically significant [34]. However, the significancy of these variables can, at times, vary depending on the specific phenomenon studied and the local dynamics that may be observed.

The percentage share of off-farm income of total income variable was statistically significant (.08) at the 90 % confidence level, suggesting that a one unit increase in the percentage of off-farm income increased by 8.12 times the likelihood of a household falling into the agricultural technology adoption category. The variable had a positive standardized β weight indicating a positive predictive capacity on the binary dependent variable, adoption of technology. This implied that households that had a larger share of their income earned from off-farm activities were more than eight times likely to invest in agricultural technologies; presumably due to access to income that allowed them to procure agricultural technology. The use of agricultural technologies improves productive capacity at the farm level.

The first hypothesis of the study was supported at the 90% confidence level for socio-demographic characteristics of age, education, and percentage share of off-farm income of total income as key variables that predicted the probability of a household's likelihood to adopt agricultural technology. These socio-economic variables were found to predict a household's likelihood to apply agricultural technology on their farms. The resultant outcome of technology adoption consequently results in community development

5.2. Networks and Community Development: Discussions and Conclusions

This exploratory study sought to establish a link between other social networks that contribute to community development, besides households relying on agriculture for their development. Survey data focusing on community development was collected from smallholder farmer households across seven of the twelve sub-counties of Kakamega County in western Kenya. These sb-counties were purposively selected from among the entire county system of Kakamega County.

Using a logit econometric model, the study estimated the impact of selected network variables to assess their impact on social research approach tested two hypotheses: socio-demographic variables are linked to agricultural technology adoption (H1) and agricultural extension is directly linked to adoption (H2). For the first hypothesis, the results supported the association between socio-demographic variables and agricultural technology adoption. Age, and education were found to predict agricultural adoption, consistent with the literature [32]. Non-farm income was also found to be a significant predictor of technology adoption. In literature, age has been found to be negatively correlated with adoption, but in the current study age is positively correlated with adoption, potentially challenging the notion that only younger farmers are more likely to adopt technology. Youth engagement in agriculture may vary from region to region based on prevailing conditions, such as available resources, access to existing resources or the level of youth empowerment.

The data analyzed did not provide enough evidence to confirm the initial prediction made by the hypothesis which predicted the existence of a direct link between agricultural extension and adoption of technology. This implies the existence of a challenge in the delivery of agricultural extension to the rural communities. The survey questions on extension did not distinguish public and private extension. Public extension, which most smallholder farmers rely on, is poorly organized and less reliable, at best, according to the focus group discussants. Further, data from the focus groups point out a lack of trust towards agricultural extension, both public and private. The framing of survey questions may not have probed the extension variable elaborately enough to bring out the core issues surrounding this agricultural service. Future studies should discriminate more clearly between farmer access to extension services, and their utilization and perceptions of private versus public extension services when adopting new technologies.

Conflict of Interest

The authors whose names are listed in this publication certify that they have no affiliation or involvement with any organization with any financial or non-financial interest in the subject matter discussed in this manuscript.

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