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RESEARCH ARTICLE

ROGER'S DIFFUSION OF INNOVATION: THE ROLE OF A CO-OPERATIVE ON FARMERS' ADOPTION OF POULTRY FARMING INNOVATIONS IN KITUI, KENYA

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ABSTRACT

Innovation in agricultural sector is inevitable. One of the key agricultural sub-sector in Kenya that innovations plays a critical role is poultry production. The indigenous poultry production in the country is still very low compared to the very high demand for indigenous poultry products. The low productivity per indigenous poultry farmer is largely attributed to diffusion of innovation to cope with the challenges of the common free-range method. In this study, using information from 326 farmers in Kitui County, the study examined the relative effect of co-operative membership compared with the effects of other socio-economic factors on farmers' adoption of poultry farming innovations. Co-operatives has a high effect compared to other socio-economic factors such as age, sex, and level of formal education. Thus, for adoption of agricultural innovation, a co-operative is a platform for innovators, early adopters and early majority. It therefore recommended that intervention programs in the agricultural sector should focus more attention on developing, strengthening and expanding farmers' co-operatives for better diffusion and use of innovations; and better linking of the social capital with extension service agencies, funders, markets, and other agricultural value chain players.

INTRODUCTION

Innovation in agricultural sector is inevitable. Diffusion of innovation should be well managed to reach the critical mass of farmers within a short period of time and be sustainable. One of the key agricultural sub-sector in Kenya that innovations plays a critical role is poultry production. The poultry production in Kenya is dualistic in nature; the commercial hybrid and indigenous poultry production systems. The commercial poultry production system comprises 23.8 percent (approximately 5,082,700 birds) of the total poultry population. The system, which is further divided into layer and broiler subsystems, relies heavily on the imported exotic parent and grandparent stock and is exclusively market oriented. In Kenya, the indigenous poultry production system is the leading poultry production system. It is largely concentrated in rural areas and comprises 75 percent (approximately 22,114,300 birds) of rural households. Approximately 71 percent of eggs and poultry meat in Kenya are derived from indigenous poultry (Republic of Kenya, Ministry of Agriculture, 2012, as cited in Kwesisi, Oloko, & Ommeh, 2015). The indigenous poultry system is characterized by free-range system in which the birds scavenge around the homestead and in the process intermingle with wild bird species. Because the indigenous poultry sector plays an important role in Kenya's food security and economic development of the country; thus the significance of smallholder farmers' adoption of innovations by farmers to enhance productivity.

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Problem Statement

The adoption of innovations can be assessed on the basis of: factors influencing farmer decision to adopt a particular innovation; and the trends and spread of innovation use after adoption (Feder & Umali, 1993). According to Marenya and Barrett (2007), sustainability of innovation adoption can be unfelt even after years of experimentations, for such reasons varying from hazards to economic constraints. Various studies have been undertaken on the adoption of innovations in agriculture. They include: the effect of economic constraints and other socio-economic characteristics (Langyintuo & Mungoma, 2008; Marenya & Barrett, 2007), information and knowledge about innovations (Spielman *et al*., 2008; Daberkow & McBride, 2003), ownership and risk (Greiner, Patterson, & Miller, 2009), and impact of co-operative social capital (Kolade & Harpham, 2014) on farmers' adoption behaviours. To build on the latter study, it is evident that there is little research attention given on effect of the smallholder

producer co-operatives on farmers' adoption of innovation; and especially data on farmer adoption factors and behaviours in Kenya's indigenous poultry sector. In this regard, this study focusses on the role of co-operative, besides other socio-economic factors, in influencing the rural smallholder farmers' adoption of poultry production innovations in Kitui County.

Research Purpose and Objectives

Based on the identified research problem and research gap, the main purpose of the study is to examine the role of co-operatives on farmer's adoption of agricultural innovations in poultry sector. In this regards, the adoption of the indigenous poultry farming innovations in Kitui County of Kenya. The study's specific objectives were:

1. To find out the likelihood that farmers in co-operatives will adopt and benefit more from innovations more than their non-co-operative farmers.
2. To find out socio-economic factors that influence the adoption of innovations, and what are the effects of innovation adoption on co-operative and non-co-operative farmers.

Study hypotheses

The null hypotheses of this study objectives were set out as follows:

1. H_o: The co-operative farmer-members are not more likely to adopt agricultural innovations than non-co-operative farmers
2. H_o: The co-operative membership does not influence the adoption of agricultural innovation more than personal attributes.
3. H_o: Co-operative farmers have no higher levels of education than non-co-operative farmers.
4. H_o: The co-operative farmer-members do not benefit more from the adoption of agricultural innovations than non-co-operative farmers.

Conceptual Framework

The study was conceptualized as in the framework illustrated in Figure 1. The figure depicts the study design model demonstrating the effect of co-operative membership on other farmer personal attributes and farmer adoption of the poultry production innovations.

Justification of the Study

There is increasing demand for indigenous poultry products. Any decline of indigenous poultry production and productivity will adversely affect the food security and the rural economies. To continually increase and maintain the indigenous poultry production, which is to meet the increasing demand, there is need for farmers to adopt innovations. Thus, there is need to examine the communication channels sources for adoption of innovations. According to Rogers (2003), "diffusion is a very social process that involves interpersonal communication relationships" (p.19). In this respect, communication is "a process in which participants create and share information with one another in order to reach a mutual understanding" (ibid, p. 5). Co-operatives are considered communication channel source for rural smallholder farmers' decision making about innovation adoption. This is the centrality of this study.

Chapter Summary

Based on the importance of the poultry sector in Kenya, the sustainability of indigenous poultry production and productivity is critical. Understanding the ways in which rural smallholder farmers adopt poultry production innovations is therefore important, hence the need for this study.

LITERATURE REVIEW

Introduction

This chapter provides an overview of the extant literature about Roger's diffusion of innovation, agricultural and poultry production, and producer co-operatives and adoption of innovation. Finally the chapter explains the existing research gap that this study seeks to fill.

Roger's Diffusion of innovation

Innovation is "an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). Further, Cardoso de Sousa, (2012) argues that innovation involves changing processes or creating more effective processes or ideas. Innovation may be adopted or rejected. Adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (Rogers, 2003, p. 177). Either course, (agri) business will be affected either positively or negatively. On this account, Rogers' diffusion of innovation theory is introduced to explain how, why, and at what rate new ideas and technology spread. Rogers (2003) define diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). Thus the process is influenced by innovation itself, communication channels, time, and a social system; and heavily relies on human capital. The innovation must be widely adopted in order to self-sustain. Within the rate of adoption of an innovation, there is a point at which an innovation reaches critical mass. The categories of adopters are innovators, early adopters, early majority, late majority, and laggards. Rogers (2003), further argues that, diffusion manifests itself in different ways and is highly subject to the type of adopters and innovation-decision process. The criterion for the adopter categorization is innovativeness, defined as the degree to which an individual adopts a new idea. The adoption of new ideas are inevitable in Kenya's agricultural sector including the poultry production.

Poultry production and its significance in Kenya

Poultry farming in Kenya has been on the rise the last ten years. The Kenya Poultry Farmer Association (KEPOFA) report of 2011 show that, this has largely been in rural and the peri-urban areas where large number of medium and large-scale poultry enterprises have thrived as a result of the shrinking land sizes, the increasing population density and the

rising unemployment rates in formal sector. The KEPOFA (2011) report thus indicates that, the poultry sector contributes to the lives of 21 million Kenyans and 6.1 percent of the country's Gross Domestic Product. In this respect, the poultry industry has the potential to generate higher earnings to the enterprises and change the living standards of its players if suitable interventions are developed and applicable strategies put in place. As such, Kenya Economic Report (KIPPRA, 2009) recognises poultry as one of the lead livestock initiatives that can contribute the Kenya's ongoing socio-economic development pillar under the vision 2030. However, because of various challenges, especially the production challenges, the poultry industry growth is still slow (KEPOFA, 2011).

Livestock production challenges

The diseases outbreak is the major challenge affecting the livestock industry in Africa. The fact that most of serious poultry diseases - New Castle and *Gumboro* - are air-borne and can remarkably affect the number of birds, making this challenge enormous. In poultry, the common infectious diseases that can be prevented through vaccinations have been reported to cause very high mortality rates in many poultry farms; 50 percent mortality rate in Togo and Sudan, 70 percent in Nigeria, 80 percent in Cameroon, 90 percent in Kenya and Zaire and 100 percent in Morocco. Thus, many farmers spend large share of their revenues treating endemic diseases (McCaster, 2009). In Africa, many livestock diseases keep on recurring because strategy is usually based on control rather than on elimination. The threat of such disease outbreaks, always results to entrepreneurial farmers avoiding poultry farming when considered risky business; since such disease outbreaks lowers the final output due to poultry deaths and low production (Portsmouth, 2003). For instance, Farrell and Stapleton (2008) found out that, many smallholder farmers in Zimbabwe are unable to buy the necessary vaccines and drugs for their livestock. This problem is compounded by the government lack of adequate funds for the sector. Moreover, veterinary officers have mobility problems to access farmers due to poor infrastructure. Thus, the underperformance of the livestock sector in the country for over two decades. In Tanzania, the scenario is no better. According to Parhurts (2010), there is inadequate facilities, veterinary services and extension officers that the livestock sector. Farmers have inadequate knowledge on disease prevention and early detection of common diseases. When there is an outbreak, the response by the veterinary officers is also slow due to poor infrastructure. The resultant poor production has seen the industry contributing a paltry of three percent to the national economy. In Kenya, the evidence is the same. Kariuki (2010) founds out that many poultry farmers lose thousands of birds as a result of the outbreak of highly infectious diseases such as New-Castle and *Gumboro*.

Technology plays a critical role in enhancing the dissemination and application of information, including information of livestock production (Portsmouth, 2003). Nonetheless, inadequate agricultural information on how to improve the productivity of their livestock, remains to be the greatest challenges for the farmers. The various interventions that have been developed in Western countries including introduction of new technologies, improved breeds, new equipment and modern management systems have not been fully implemented in most African countries (Lukoye, 1998). Where implemented, the results and transferability were often disappointing, because of an inadequate understanding of the specific and historical context in which these activities were developed (Biggs & Matsaert, 2004). These are all the dimensions of "diffusion of innovations" theory as illustrated by Rogers (2003).

Rural smallholder producers and agricultural innovation

One of the key elements of diffusion of innovation is social system. Social system as "a set of interrelated units engaged in joint problem solving to accomplish a common goal" (Rogers, 2003, p. 23). In agricultural sector, rural farmers are key players in innovation system being the primary users of agricultural innovations. According to Assefa (2005), there is still a gulf between formal and farmer innovation systems, and a lack of recognition that farmers, especially resource-poor farmers, continually innovate in order to survive. Rural people own knowledge (indigenous technical knowledge) should be viewed as dynamic knowledge, not 'business as usual', but 'business unusual'. Persistence with farmer innovation has led to well documented success stories (Reij, 2005). A series of detailed studies from across Africa demonstrate how smallholder farmers experiment and innovate in order to improve their livelihoods despite adverse economic and agri-environmental conditions (Reij & Waters-Bayer, 2001). The duo postulate: "participatory approaches to agricultural innovation that build on local knowledge and innovation can stimulate and diffuse innovation capacity among farmers and external scientists; farmer innovation in the context of sustainable agricultural and natural resource management can lead to innovative ways of reducing dependence on external inputs; innovative techniques often represent 'new' approaches in the local context – adaptation of existing knowledge - rather than the generation of completely new ideas, although their development was the result of local creativity and innovation rather than simple technology transfer". Enweze (2005) emphasises that, "only innovations that have been identified by poor people themselves will make a difference in agricultural development. The central point that the poor should be involved is assumed; also, that rural know-how and culture are assets, and that it is important not to underestimate the capacity of the poor to innovate". In essence, the approaches to agricultural development that take local innovation as their starting point can tap into a rich source of creativity, ingenuity and perseverance of smallholder farmers. Nevertheless, there are areas of innovation which arise from formal systems and generic technologies, and from outside the rural areas, that can be brought to bear on indigenous farming techniques by adaptive processes; while considering the five attributes of innovation: observability, relative advantage, compatibility, complexity/simplicity, and trial ability (Rogers, 2003). This need to be well communicated through a communication channel sources such as the producer co-operatives for rate of adoption – the "the relative speed with which an innovation is adopted by members of a social system" (ibid, p. 221).

Co-operatives and adoption of agricultural innovation

Rogers (2003) asserts that the diffusion of innovation relies heavily on human-social capital. The social capital's role in the development and diffusion of innovations has been explored by several researchers. Hence, it has become one key factors

considered by scholars in a discussion of the speed and rate of adoption (Deroian, 2002; Valente, 1996; Rogers, 1995&2003; as cited in Kolade & Harpham, 2014). Social capital, with its unique emphasis on relational tools, comprises a vital, element in the success of innovations, in addition to engineering process and the role of markets (Landry, Amara, & Lamari, 2002). Social capital takes the form of trust, norms, and networks, and it is in these contexts that the role of co-operatives can be examined with regard to the adoption of innovations (Novkovic, 2008). By their inherent value and principles, co-operatives fundamentally generate and rely on social capital (Valentinov, 2004). Studies have shown that when farmers become members and participate in co-operative there is increase the adoption of agricultural innovations. Among other things, it was suggested that information and knowledge about innovations spread more quickly within a co-operative organisation compared with individual farmers, and this enhances confidence about innovative practices and helps facilitate a more efficient implementation and application. Also, there is better access to credit for members of co-operatives, compared with their low-income individual counterparts, and availability of funds has a positive correlation with a higher rate of the adoption of innovations (Deji 2005; Nwakwo, Peters, & Bolkemann 2009). The co-operatives are able to engage different ways for the diffusion of innovations. These include: technical and commercial information provided by means of periodic fliers and posters and messaging distributed among members; talks, meetings, field demonstrations, and educational courses are also arranged for members to learn new production techniques, and co-operatives often appoint some members in their ranks to specialist teams whose responsibility is to explore and design improved methods and subsequently provide feedback and relevant advice for members (Manrique, *et al*. 2002). The type of technologies for indigenous poultry farmers include, improved breeds, vaccinations and poultry housing. These agrcultural innovations, are well applicable in their design and applications to groups of farmers than individual households, and this is where the role of co-operatives is even more significant. For they can contribute significantly to agricultural development (Royer, 2014; Bello, 2010) whilst building social capital (Richards & Reed, 2015; Poole & Donovan, 2014).

In reference to the economies of scale, farmer groups, rather than individual farmers, benefit optimally from adoption of innovation, are better positioned to share and mitigate innovation risks, and can deal more effectively with limits arising from the amount of innovation procurement, application, and maintenance costs (Kolade & Harpham, 2014). The major hypothesis of this study is that the co-operative membership reduces the bottlenecks to accessibility and adoption of agricultural innovations. It is argued that information about, access to, and benefits from agricultural innovations are more easily available in co-operatives. Furthermore, because of high ratio of farmers to extension officer, extension officers are able to work more effectively and efficiently with farmer groups, rather than individual holders. Finally, co-operatives may be able to contribute funds for purchase of equipment and seeds for group demonstrations and use (Adeogun, Olawoye, & Akinbile 2010). Thus, co-operatives are social structures that can promote adoption of agricultural innovations among farmer-members.

Chapter Summary

Innovation in agriculture, including the livestock and more specifically the poultry sector, is inevitable. The significance of poultry sector cannot be overemphasised. Poultry farmer adoption of agricultural innovation for increased production and productivity cannot be ignored. An important component of the farmer innovation approach and adoption is to enhance communication between various development actors and farmers who are looking for or have found innovative solutions to smallholder farming challenges. A key challenge for effective farmer innovation approach and adoption is dissemination of technology and methodology. There is also an important role for farmer-to-farmer exchanges and exploitation of indigenous systems and channels for sharing agricultural information and inputs, rather than absolutely relying on (under-resourced) formal extension systems to disseminate innovations (Reij & Waters-Bayer, 2001). The critical challenge is to develop, establish and strengthen farmers' structure in strengthening the innovative capacity and adoption of the innovation by the farmers. This requires a redefinition of the co-operatives that promote and share information on innovation agendas.

According to various studies that have focused on adoption of innovation, there are very few studies that focus on social capital factors such as co-operative membership. Kolade and Harpham (2014), while studying on "impact of co-operative membership on farmers' uptake of agrcultural innovations in Southwest Nigeria", suggested that more research be done to compare the social capital of co-operative and non-co-operative farmers, for instance with respect to access to general and technical information, that is education and training. Specifically, no literature exists on the social capital of co-operatives in adoption in East Africa, leaving a vacuum that this study required to fill.

RESEARCH METHODOLOGY

Introduction

This chapter covers the methodological framework that the researcher adopted in conducting the study. The chapter presents the study h design, the sample size and sampling techniques, tools that were used to collect data, and the approach that was used in the analysis of the collected data.

Research Design

This is a descriptive survey. Kothari and Garg (2014) defines a descriptive survey as "a method of research which gathers data at a particular point in time with the intention of describing the nature of existing conditions of, or determining specific information". The study describes the adoption of the poultry farming innovations by the rural smallholder farmers in Kitui County of Kenya.

Sampling Technique and Population Size

Purposive and random sampling techniques were employed to get the sample study respondents from Kyalele, Katwala and Kanduti locations of Kitui East and Kitui Rural Sub-Counties

in Kitui County; where the indigenous poultry farmers have established 'Nguku' (Poultry) Producers and Marketing Co-operative Society. The target population in this study was indigenous poultry farmers was 3200. A sample size of 326 farmers, 138 co-operative members and 188 non-co-operative members was randomly selected.

Data Collection Methods

Using the techniques set out above, data was elicited from poultry farmers using structured and semi-structured interview schedules. Because of the time and resource constraint, the researcher capitalised poultry farmer meetings organised by Farm Africa and Kitui Development Centre (KDC), who are development partners working with poultry farmers in the County and '*Nguku'* Co-operative. Because, indigenous poultry farming is considered a 'women' farming activity, the researcher purposively interviewed one male in every three farmers. In the interview schedule, the adoption of agricultural innovation was the dependent variable in the study, and was measured by rate of adoption, and duration of use. In the study, a total of three innovations were studied in this study: the improved poultry breeds, vaccinations, poultry housing and feeding. To measure the rate of adoption, respondents were questioned if they used the listed innovations, and to access the duration of use, data was acquired using four timeframes: last 1 year, 1–2 years, 2–3 years, and more than 3 years when the Farm Africa's poultry production and marketing project was introduced and implemented by KDC. For the independent variables, co-operative membership was measured using farmers' response to such question as to when they joined the co-operative and reasons and benefits of the co-operative. In addition, personal attributes and socio-economic factors considered are age group, sex, level of education, and non-farm income.

Data Analysis

Data collected from the respondents was processed and analyzed. Descriptive statistics was used to analyse quantitative data by obtaining the frequency distributions and cross-tabulation analyses of the variables, and to explore some associations between them. According to Orodho (2005), this is the simplest way to present data. Quantitative data was analyzed using statistical package for social scientist, SPSS. Using the SPSS version 20, multiple regression analyses were done to evaluate the combined effects of the independent variables (co-operative membership and socio-economic characteristics) on the predictor variable (on use of agricultural innovations). Standardized Beta coefficients were used to obtain the combined effects of the independent variables on the dependent variable (Bryman & Cramer 2009). The equation for the multiple regression model is given as follows:

$$yi = \beta 1xi1 + \ldots\ldots\ldots + \beta pXip + ei = xiTb + ei,$$
$$i = 1, \ldots, n,$$

where yi represents the adoption of agricultural innovations (the dependent variable), xi are the independent variables or regressors, β is a *p*-dimensional parameter vector, and ei is the error or disturbance term which captures all the other factors influencing the dependent variable other than the regressors. The analysis of variance was used to assess the overall significance of the model used using $p < 0.05$ as criteria of significance. In addition, we obtain the adjusted R^2 value to find the contribution of our model to the overall variance in adoption of the agricultural innovation.

One key disadvantage related to the ordinary least-square method of linear regression analysis is the presence of endogenous regressors leading to inconsistency in factor estimations. For this study, this challenge was mitigated through the analysis of factors influencing the adoption of agricultural innovations, for some endogenous regressors identified. Hence, the tactic of instrumental variables, based on a two-stage least-square method, was used to analyse the variables for adoption of agricultural innovations. As highlighted above, the challenge of endogenous regressors was considered less significant on use strengths, since respondents in the case were already adopters. The instrumental variable was chosen such that it did not directly influence the dependent variable, but has an effect at least one of the other regressor. Therefore, the first condition of selecting an instrumental variable was that it must be exogenous (uncorrelated with the error). Secondly, the instrument variable must be at least the same number of instrumental variables as there are regressors (explanatory variable). This condition is known as 'just identified'.

Therefore, in this study, the dependent variable is adoption of agricultural innovation, one of the independent variables is education level, and education institution is selected as an instrumental variable, since it can have an effect on education level, but no direct effect on adoption of agricultural innovation. While regression analysis show relationships between variables, it does not show causality. But with respect to the question of whether adoption of agricultural innovation is caused by co-operative membership, or otherwise; the logical justification for the conjecture in this study is that co-operative membership can strengthen the factors involved in the stages that come before adoption of innovation, including information and awareness. In other words, whereas the co-operative can influence awareness of agricultural innovations, adoption of agricultural innovation does not logically lead to awareness of the innovation. Nonetheless, other avenues for information and other forms of social capital exist outside co-operatives. A comparative analysis of the social capital of co-operative and non-co-operative farmers is a priority for future research.

FINDINGS AND DISCUSSIONS

Summary of independent variables: frequency distributions

The study we observed that 42.3 percent of respondents were co-operative members, 70.2 percent are female, and 54.9 percent of farmers were 45-years old, and the 54.6 percent had no access to non-farm income. This is illustrated in the Table 1 below.

Rate of adoption of agricultural innovation

The data on farmers' adoption of the listed agricultural innovations were analysed using frequency distributions. Results of the findings are shown in Table 2. The rate of adoption is described as the percentage of farmers who adopted

the agricultural innovation in the year of observation, from the reference year in which the innovation was first introduced. Majority of the innovations under investigation were introduced about 4 years ago, when the Farm Africa with funding from Big Lottery implemented with in support of KDC a three year poultry production and marketing project (PPMP), so 2013 is taken as the approximate year of reference of the introduction of agricultural innovation for indigenous poultry farmers, and the year 2016 as the year of observation. The results indicate that the highest adoption rates are for vaccination and feeding, at 89.9 percent and 86.8 percent, respectively. Adoption of feeding high-breed species is considerable above 25 percent. Of all the innovations examined, adoption of housing is still low at 28.8 percent.

Table 1. Frequency distribution

Variable	Frequency	Percentage
Co-operative membership		
None-members	188	57.7%
Members	138	42.3%
Total	326	100.0%
Gender		
Male	97	29.8%
Female	229	70.2%
Total	326	100.0%
Age group (years)		
18–25	8	2.5%
26–35	37	11.3%
36–45	102	31.3%
46–55	104	31.9%
55+	75	23.0%
Total	326	100.0%
Annual non-farm income (Kshs.)		
None	178	54.6%
Less than Kshs 30000	70	21.5%
31,000–60,000	39	12.0%
61,000–90,000	24	7.4%
91,000–120,000	8	2.5%
181,000 or more	7	2.1%
Total	326	100.0%
Annual poultry farm income (Kshs.)		
Less than Kshs 60,000	209	64.1%
61,000–90,000	70	21.5%
91,000–120,000	35	10.7%
121,000–150,000	6	1.8%
151,000–180,000	1	0.3%
181,000 or more	5	1.5%
Total	326	100.0%

Table 2. Use of innovation

Innovation	Frequency	Usage	Non-usage	Rate (% of usage)	Adoption speed
Housing	326	94	232	28.8%	7.2
High breed species	326	112	214	34.4%	8.6
Vaccination	326	292	34	89.6%	22.4
Feeding	326	283	43	86.8%	21.7
Total				239.6%	59.9
Average				59.9%	15.0

The speed of adoption is measured as the ratio of adoption rates and the number of years, taken as four, since the introduction of the agricultural innovations by the project. This provides additional information on the spread and acceptance of the agricultural innovations since the time of the first introduction. The figures for adoption rate, in Table 2, indicate that the highest speed of adoption is for vaccinations at 22.4 percent per year. Also, the average speed is 15.0 percent per year for all the four agricultural innovations investigated, and the speed is especially low for adoption of housing, at 7.2 percent per year. The subsequent analyses focus on the effect of personal attributes and socio-economic factors on the rate and speed of adoption, and how co-operative membership affects these socio-economic indices, as well as directly influences the adoption of innovations.

Co-operative membership and adoption of innovations

The results of the cross-tabulation and chi-square tests on the effect of co-operative membership on adoption are summarized in Table 3. The chi-square values are high for all innovations. With significance levels of 0.000 for high-breed poultry species, vaccinations, feeding, and housing, the chi-square values are 29.158, 18.209, 27.285, and 26.280 for high-breed poultry species, vaccination, feeding, and housing, respectively. This leads to the rejection of the first null hypothesis, affirming the suggestion that co-operative farmers are more likely to adopt the listed innovations than their non-co-operative counterparts. The implications of these results are discussed in greater detail in the next section, in the context of other personal and socio-economic variables.

Table 3. Co-operative membership and adoption of agricultural innovations

Variable	Non-co-operative member	Co-operative member	Total
Adoption of Housing			
Non-Adopters	94	27	121
Adopters	94	111	205
Total	188	138	326
Adoption of high breed species			
Non-Adopters	111	28	139
Adopters	77	110	187
Total	188	138	326
Adoption of vaccinations			
Non-Adopters	45	4	49
Adopters	143	134	277
Total	188	138	326
Adoption of feeding			
Non-Adopters	54	6	60
Adopters	134	132	266
Total	188	138	326
Pearson chi-square	Value	df	Asymp. sig. (two-sided)
High-breed species	29.158	1	0.000
Vaccinations	18.209	1	0.000
Feeding	27.285	1	0.000
Poultry Housing	26.280	1	0.000

Co-operative membership and socio-economic factors

For the purpose of this analysis, the focus was on: poultry feeding methods, improved poultry breed, vaccination practices, and poultry housing. The results of the analysis are summarised in Table 4.

The key factor of this analysis is the acquisition of the formal education, measured in terms of level of education by individual poultry farmers. Previous adoption studies for low-income farmers have focused majorly on assessment of farm

and non-farm income and access to land as indices of farmers' economic capabilities.

Table 4. Instrumental variables analysis of adoption factors

Variable	Std. error	Beta coeff	*T*-value	*P*-value
Feeding				
(constant)	0.687		1.714	0.088
Age group	0.012	−0.562	−1.285	0.200
Sex	0.235	0.080	0.211	0.833
Level of education	0.001	0.055	0.071	0.943
Co-operative membership	0.228	0.438	1.109	0.268
Farm income	0.000	0.036	0.224	0.823
Vaccination				
(constant)	1.056		2.401	0.017
Age group	0.018	−1.550	−2.211	0.028
Sex	0.362	−0.395	−0.652	0.515
Level of education	0.002	−0.836	−0.680	0.497
Co-operative membership	0.350	0.907	1.431	0.154
Farm income	0.001	0.079	0.307	0.759
High-breed species				
(constant)	1.118		−0.020	0.984
Age group	0.019	0.275	0.668	0.505
Sex	0.397	−0.101	−0.267	0.790
Level of education	0.002	0.721	0.984	0.326
Co-operative membership	0.352	0.077	0.212	0.832
Farm income	0.001	−0.121	−0.823	0.412
Housing				
(constant)	1.210		0.428	0.669
Age group	0.021	−0.005	−0.011	0.992
Sex	0.413	−0.180	−0.426	0.671
Level of education	0.003	−0.380	−0.450	0.653
Co-operative membership	0.392	0.319	0.733	0.464
Farm income	0.001	−0.173	−0.981	0.327

Nonetheless, the acquisition of education, often in primary, secondary or post-secondary, can play an important role as a measure of farmers' social capability. Additionally, in the case of adoption of agricultural innovation and the potential benefits of higher yield and up-scaling and expansion of farm activities, education access can be even more important, in terms of its positive effect on the social conditions of farmers in quick acquisition and application of information of innovation.

Income levels

The results illustrated in Table 4 indicate that farmers' income levels, measured in terms of farm income, generally have some influence on the adoption of innovations, especially vaccinations. This is in agreement with the findings of researchers who have reported a linear relationship between wealth/access to income and adoption of innovation (Feleke & Zegeye, 2006; Odoemenem & Obinne, 2010), unless one was avoiding the farming risks (Languituo & Mungoma, 2008). The regression analysis results here appear to show that income does not have a significant effect on adoption of feeds and feeding. This could be because, Kitui being a semi-arid area, exhibited with frequent droughts and hunger, the farmers may not invest their earning for poultry feeds during the hunger seasons, and can use the local ingredients (especially grains) to formulate poultry feeds during harvest periods. Information on adoption does not, however, reflect details regarding level of use, or adequate poultry feeding programme in terms of quantity. Naturally, more well-off farmers (a few in employment or other businesses or retirees) feed their poultry, in adequate quantities, than farmers with lower access to income

Sex

Considering individual farmer, rather than the household, as the unit of observation, this study mitigated the weakness the household study models, which in many cases loses important data regarding the adoption behaviour of female farmers in male-headed households (Doss & Morris 2001). This study results show that the effect of is quite significant, especially for feeding, vaccination, and housing. Unexpectedly, the effect of female on adoption of new model poultry housing is high, demystifying the notion of the physical nature of developing and maintaining the poultry housing innovation. This could be attributed to the group peer pressure the female members get from other informal women groups.

Age

The effect of age on adoption seems to be comparably minor for all agricultural innovations examined, and negative for all but high-breed species. Some studies established a positive correlation between age and adoption of innovations; on the basis that farmers' enhanced entrepreneurial experience with increasing age, which in turn positively influences adoption of innovation (Tanui, *et al*. 2012). Nonetheless, in this study and as illustrated in Table 4.4, older farmers are, in general, less likely to adopt innovations than their younger farmers, even though the effect is noticeably lower than other variables. This could be attributed to the vigour the young farmers wants to bring to the sector, knowing that it is not just more for food security but for employment and income generation; thus seeking and applying relevant information on agricultural innovations.

Level of education

Studies on adoption of innovation have generally, found a positive correlation between education and uptake of innovations (Kolade & Harpham, 2014; Feleke & Zegeye, 2006). This investigation indicates that the effect of education is positive for poultry feeding and high-breed species. This is corroborated by the findings of Sidibe (2005), who explored the effect of education in a wider context, not merely of formal qualifications, but also of specialized training accessed by farmers. Other findings affirmed that more educated farmers are more likely to adopt more complex and knowledge intensive innovations (Kolade & Harpham, 2014; Odomenem & Obinne, 2010). Thus, the negative effect of level of education on adoption of poultry housing in this study is unexpected, but the rest of the data appear to show that the effects of other factors are more decisive regarding the adoption of advanced poultry housing. This could be caused by the Kamba cultural context of the study population, which may be eroded completely by formal education levels.

Co-operative membership

The co-operative membership was the main independent variable explored in this study, and the study model shows that it is the greatest contributor across the whole range of innovations explored. Co-operative membership is often the highest or the second highest contributor to adoption of innovation (Kolade & Harpham, 2014; Odomenem & Obinne, 2010). The co-operative unique by their intrinsic effect on other factors of adoption, such as access to information sharing

and dissemination, group awareness and trainings, finance and peer-pressure (see Kolade & Harpham, 2014; Sidibe, 2005). External funding agencies, including donors, prefer to deal with groups rather than individual farmers in the disbursement of grants. Co-operatives also offer ground for members irrespective of age, sex and education to have opportunities for social learning and development of management skills (Hartley & Johnson 2014). From these results, the study therefore the second null hypothesis is rejected. As the data show, when compared with other socio-economic variables, co-operative membership appears to exert the most significant effect on the adoption of agricultural innovations. As observed, the extent of the co-operative effect can also be measured by the potential positive effect it can have on other variables, as discussed above. The co-operative structure relies on, generates, and strengthens social capital. Thus, the educated co-operative farmer is likely to benefit more from information and technical training arranged or facilitated under the support of the co-operative, and the uneducated co-operative member can mitigate his/her disadvantage by regular contact with other farmers in meetings, training, and field demonstrations. Moreover, the older farmer can access inputs from the co-operative without travelling to the town. Equally, the younger co-operative farmer can benefit more than their non-co-operative counterpart from the wealth of experience of older members of the co-operative. The co-operative organisation thus becomes a platform in which the socio-economic characteristics of individual farmers can be strengthened and consolidated.

Co-operative membership and level of education

In the foregoing analyses, it is observed that level of education exerts little influence on adoption of innovations. The results in Table 5 lead to the acceptance of our third null hypothesis, which in turn confirms that co-operative farmers indeed have no higher levels of education compared to non-co-operative members. This is partly because the level of formal education is not a significant consideration in adoption of agricultural innovations. Innovation is not necessarily formal but also based on the indigenous technical knowledge which when encouraged and blended with the formal ones, can be give the desired results of innovation adoption (Reij, 2005; Enweze, 2005; Assefa, 2005; Reij & Waters-Bayer, 2001). This seems to be the case in the study, which the agricultural innovations adopted were only to catalyse their original approaches, an explanation that fits well with the indication of the high speed adoption of 15.0 percent per year. Thus, with the more informal farmer trainings and information sharing and peer-pressure with even the illiterate farmers, the more the overall poultry production increases.

Co-operative membership and benefit of innovations

Because there are potential contributions of various factors, including the changing cost of farm inputs and labour, seasonal changes in prices of agricultural outputs, cost of transportation, and access to markets; to benefits of innovation by the farmer,

Table 5. Co-operative membership and level of formal education

Variable	No formal education	Primary education	Secondary education	Post-secondary education	Total
Co-operative members					
Non-members	49	64	44	31	188
Members	68	49	12	9	138
Total	117	113	56	40	326
Pearson chi-square	Value	df	Sig. (two-sided)		
Co-operative membership	54.147	3	0.051		

Table 5. Co-operative membership, adoption of innovation and poultry farm incomes

Variable	Annual poultry farm incomes (Kshs.)						
	Less than Kshs 60,000	61,000–90,000	91,000–120,000	121,000–150,000	151,000–180,000	181,000 or more	Total
Co-operative membership							
Non members	140	25	11	4	1	0	181
Members	69	45	24	2	0	5	145
Total	209	70	35	6	1	5	326
High breed species							
Non adopters	107	24	9	3	0	0	143
Adopters	102	46	26	3	1	5	183
Total	209	70	35	6	1	5	326
Vaccinations							
Non adopters	32	9	4	2	0	2	49
Adopters	177	61	31	4	1	3	277
Total	209	70	35	6	1	5	326
Feeding							
Non adopters	38	12	7	2	0	1	60
Adopters	171	58	28	4	1	4	266
Total	209	70	35	6	1	5	326
Housing							
Non adopters	82	22	13	2	0	2	121
Adopters	127	48	22	4	1	3	205
Total	209	70	35	6	1	5	326
Pearson chi-square	Value	df	Asymp. sig. (two-sided)				
Co-operative membership	26.5	6	0.000				
High breed species	21.7	6	0.001				
Vaccinations	3.22	6	0.781				
Feeding	7.41	6	0.285				
Housing	1.92	6	0.927				

it is difficult to measure such farmer benefits. Nonetheless, cross-tabulation and chi-square tests in Table 6 there is relevant information, which informs the estimates of the benefit of adopted innovations and co-operative membership. The basic unit of measure employed in this respect is the average annual indigenous poultry farm sales/incomes. The results show that co-operative membership is positively correlated with indigenous poultry farm sales, and the Pearson chi-square coefficient obtained at 26.545, at a significance of 0.000. In essence, co-operative members are about 26 times more likely to make better indigenous sales than their non-co-operative counterparts. Regarding the effect of individual innovations on farm sales, only high-breed chicken is found to have a positive correlation at acceptable significance levels, of 0.001. The Pearson chi-square co-efficient is 21.658 for high-breed chicken. The chi-square coefficients for the other three agricultural innovations (feeding, housing and vaccination) are comparatively low, and at unacceptable significance levels more than 0.05, leading to the rejection of the null hypotheses. It would seem that the adoption of agricultural innovations, especially the three identified above, does not necessarily guarantee benefit to farmers in terms of increased sales and associated profits. However, it must be observed, that sales in itself is not necessarily a measure of productivity, but it can also vary in seasons or mode of selling, say, collective marketing.

An important inferences from the analysis is the critical co-operative's role in aiding more beneficial adoption of agricultural innovations. This affirms the forth study hypothesis, and is consistent with the findings of other studies (Kolade & Harpham, 2014; Wollni & Zeller, 2006), that co-operative membership plays a significant role in mitigating the barriers to continued adoption of innovation by facilitating optimum benefit and better profit for adopters; bringing more profit for the co-operative farmer than their non-co-operative counterpart. This may be attributed to the collective bargaining and marketing and economies of scale accruing from the use of the co-operative by farmer-members.

Summary of Findings, Implication, Limitation, Further Study and Conclusion

Findings Summary

This study found out that co-operative membership has a significant influence on farmers' adoption of the poultry farming innovations, compared to all other socio-economic variables. Thus, it is possible that the adoption of agricultural innovations can encourage and motivate some farmers to become members of co-operatives. However, the sequence of the adoption process indicate that it is more likely, at least with regard to initial awareness and technical information about innovation and blending with indigenous technical knowledge, that co-operative membership influences or encourages adoption and greater use of agricultural innovations. This co-operative effect is especially important in light of the strengthening impacts it can have on other socio-economic variables influencing the adoption of agricultural innovations. This is because, co-operatives are platforms of collective awareness and economies of scale for accessing both input and output markets. Among the list of socio-economic factors, educational level of respondents appear to be especially important. The role of sex is surprisingly important for some innovations, like adoption of housing. The women's adoption and application and management of the poultry structures is a surprise. In essence, a co-operative is a platform for innovators, early adopters and early majority; more so when the farmers' ingenuities and creativities are considered in the formal and foreign systems and generic technologies, for them to adopt such innovations through adaptive processes. Additionally, this study provide insights into the benefits of innovation adoption, and of co-operative membership, using poultry farm incomes as a measure. The results shows the positive correlation of co-operative membership with poultry farm incomes, and the positive correlation of adoption of high-breed species with farm incomes. Thus, it is concluded that adoption of agricultural innovation in the co-operatives can be more beneficial for adopters, compared with adoptions by non-co-operative members, due to the more favourable economy of scale, potential collective bargaining power and marketing strategies and bargaining power, and possible value addition opportunities.

Implications

The implication of the study findings is that, a co-operative is an effective platform to build and strengthen interpersonal communication relationships among the *'heterophilous'* adopters (Rogers, 2003, p.19) of agricultural innovations. This in turn influences, positively, other socio-economic factors in adoption of agricultural innovation. There are other farmer groups that in ad-hoc manner are established to meet certain needs for the donors and other agencies. However, such groupings do not provide the regularity and security of the co-operative arrangement, which gives farmers an opportunity for future, and a more reliable podium to enjoy collective support and collaboration with external stakeholders. Co-operatives are best farmer communication channel for the Rogers' (2003) innovation-decision process of knowledge, persuasion, decision, implementation and confirmation. Given that innovation-diffusion process is "an uncertainty reduction process" (ibid p. 232), co-operatives are the farmers' best platforms for innovations' observability and trial ability to gauge relative advantage, complexity/simplicity and compatibility among the rural smallholder farmers. Today, food insecurity and unemployment is on the rife in Kenya. One key probable reason could be the underdevelopment and underutilisation of the smallholder producer co-operative platforms in Kenya. Under the new constitution, in which co-operative is a devolved function; it is therefore recommended that the County Governments develop, strengthen and expand smallholder producer co-operatives to facilitate the better diffusion of innovations among rural farmers, and help farmers to benefit optimally from the adoption of innovation. The co-operative will help ease co-ordination and provision of agriculture extension services, finance support and development of light industries by the farmers, thereby enhancing food security and creating job opportunities for the youth.

Study Limitations

Several limitations of this study pertain to the population, sample, and the data analysis method used to examine the relationship between variables. The sample consists of poultry

farmer in two sub counties of one county in Kenya. First limitation of this study, therefore, is the inability to generalize the results across other smallholder producer co-operatives. The co-operative was also initiated by a donor funded project and the study population is early adopters. One recommendation is to construct a similar study, using a different population type to explore the objectives across different cultures and types of producer co-operative organisations. Secondly, the study interview schedule did not comprise a tested scale for some of the constructs, so proxies were used. Although the assessment of the measures provided support for the reliability, validity and practicality in the study, future research should examine these constructs using instruments originally designed specifically for them if any.

Future Studies

The above study limitations notwithstanding, the present study has made contribution to address the identified knowledge gap in the existing literature in co-operatives and adoption of innovation and responded to calls for research. However, in future a study may be undertaken to evaluate the culture of rural smallholder farmers and key stakeholders of the effectiveness of the co-operative arrangement, and opinions on institutional challenges – such as markets, infrastructure, credit institutions, and policy – to successful innovations. This study may use a qualitative approach, with in-depth interviews with key stakeholders, and semi-structured interviews with farmers, to fill the knowledge gaps, and finally inform better practices in terms of future intervention programs by the Government and development partners in promoting agricultural innovations among the rural smallholder farmers.

Conclusion

The main objective of this study was to deepen understanding of the role of co-operative membership on the adoption of agricultural innovation among rural smallholder farmers. The co-operatives by their nature have greater influence on other socio-economic factors that in turn impact on the adoption of innovations among the rural smallholder farmers. It is hoped that this study prompts further investigations the co-operative model that can promote speedy adoption of agricultural innovations.

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