

Impact of the Meru KOPIA project on poultry farmers' income in Meru County, Kenya

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ABSTRACT

Most farming households in Kenya keep indigenous chickens in scavenging systems characterized by low productivity. In response to this, the Korea Program on International Agriculture (KOPIA) center in Nairobi collaborated with the County Government of Meru to disseminate localized technologies and provide technical support to indigenous poultry farmers using the model village approach. The aim of this paper is to assess the impact of the project on participating poultry farmers' income in Meru County, Kenya, as promoted by the KOPIA. Descriptive cross-sectional survey research was adopted to achieve the objectives of the paper. Data was collected from beneficiaries and a control group through a survey of 236 households using researcher-administered questionnaires sampled from a population of 400 farmers drawn from the 4 participating villages. The study was based on the rational choice theory. Propensity score matching was used to compute the average treatment effect on the treated. Using the nearest neighbor, caliper-based, and kernel-based matching methods, the results showed evidence that program beneficiaries increased their annual income from poultry production, ranging from Kshs 66,616 to 81,674. Being located in Mbaria, Ng'onyi, and Ntalami model villages, the number of livestock enterprises, the number of eggs sold, the number of hens sold, and egg production per hen influenced the impact of the project. The study recommends the establishment of more model villages so as to spread the benefits to a wider area. Future efforts should include addressing constraints in marketing and group cohesion so as to increase the benefits to the participating farmers. Assisting farmers to form a marketing cooperative will not only increase market participation but also benefit farmers from collective procurement of inputs as well as credit for enterprise expansion.

Keywords: Impact, Indigenous Chicken, Kenya, Meru County, Smallholder Farmers

I. INTRODUCTION

With the expected increase in population, agriculture will have to make noticeable adjustments to produce enough food. However, reduced productivity of the major crops and livestock enterprises, has affected the majority of African countries whose economies rely on agriculture leading to high levels of poverty and hunger (Wiebe et al., 2021). Agriculture, the mainstay of Kenya's economy, plays a critical role in ensuring food and nutrition security for the Kenyan population. The sector contributed approximately 23 percent of total Gross Domestic Product (GDP) and an additional 17.1 percent to GDP through linkages to other sectors such as manufacturing, distribution and services (Kenya National Bureau of Statistics, 2021). Product diversification is thus an important aspect of agribusiness strategy especially for small scale producers for increased profitability, reduction in risk, increasing competition, higher growth and more efficient resource allocation.

In the limited livelihoods diversification that poor households tend to have, livestock constitutes an important source of income and in general comprises the most important asset. In some of the developing countries including Kenya, rural poultry farming has been recognized as an important tool for income generation as well as improvement of livelihood for the rural poor (Acosta *et al.*, 2021). The birds are kept and raised in a wide range of production systems, and provide mainly meat, eggs and manure. In addition, chicken buffer households' income and consumption shock since livestock holders usually first sell small animals such as poultry. Poultry is thus an important enterprise for small holders making it one of the fastest growing agricultural sub-sectors (Mottet & Tempio (2017).

In Sub Saharan Africa (SSA), rural chicken production accounts for about 60% of poultry with indigenous chickens constituting 70% of the total chicken population (Kejela et al., 2019). In Kenya, poultry production remains a key enterprise among smallholder farmers (Ayieko et al., 2015), with about 70% of the rural population deriving their livelihood from poultry production (Kamau et al., 2018). Further, the poultry enterprise has been identified as an exit strategy in addressing food scarcity among rural households (Milkias et al., 2019). However, the production of indigenous poultry among smallholder farmers encounters several challenges. In Kenya, the challenges include the

rising costs of farm inputs resulting from competition of key raw materials (Abadi et al., 2018). In addition, poultry farmers are unable to control diseases related to poultry as a result of the increasing costs of vaccines and management fees (Milkias et al., 2019). There is limited information regarding both input and output markets which leads to stiff competition within the industry (Abadi et al., 2018).

Demand for animal food products in developing countries like Kenya is rising and the trends in consumption and production strongly suggest that much of the demand for meat will have to be met through increased poultry production (Delgado et al., 2001). Further opportunities are expected within the chicken industry, which is projected to record the highest growth of 121% within the livestock sub-sector by the year 2050 (Mottet & Tempio, 2017). Developing countries like Kenya are expected to play a key role in spurring this growth at the rate of 2.4% compared to 1.8% at the global level for chicken production (Mottet & Tempio, 2017).

Most indigenous chickens in Africa are farmed in traditional scavenging systems (Guèye, 1998). They are better adapted to the scavenging systems, where they are exposed to disease, food that is deficient in quantity and quality, poor housing and health care. Management interventions are limited or non-existent under these systems (Tadelle et al., 2000). Thus, despite the capacity of indigenous chicken to contribute to the economy and reduce poverty levels among the poor rural households, the enterprise is still constrained by low productivity and slow maturity (Kenya Agricultural Research Institute [KARI], 2011; Kingori et al., 2010). To address these constraints improved indigenous chicken (IIC) technologies have been developed and introduced to smallholders.

The importance of agricultural technology adoption in ending poverty and food insecurity has been well discussed. Technology adoption is expected to increase productions, efficient uses of inputs, and farmers' income. The adoption of yield increasing technologies, in Asia, resulted with what is known as the Green Revolution (World Bank, 2008) and its replication in African countries is considered to be important for increasing productivity. Various studies have shown that technologies have positively increased farm productivity including poultry technologies (Mwiti et al., 2021), improved varieties (Hailu et al., 2014; Addison, 2022, Mensah et al., 2021), Chemical fertilizers (Hailu et al., 2014; Addison, 2022), mobile phone-based money transfer services (Kirui et al., 2013), genetically modified (GM) crop technology (Brookes, 2022), and climate resilient technologies (Samuel et al., 2021). The multiplier effect is expected to increase income and food security, alleviate poverty and generally improve the welfare of small farmers.

In Kenya, just like in other sub-Sahara Africa (SSA) countries, productivity lags behind that of other regions in the world, and is well below that required to achieve food security and poverty goals. One way of increasing agricultural productivity is through introduction and use of improved agricultural technologies. However, inadequate assimilation of technology is limiting the rate of agricultural growth over time, and thus affect both quantity and quality of what is produced. The National Agricultural Sector Extension programme (NASEP) (Government of Kenya, 2012) addressed these weaknesses by articulating the importance of clientele participation and demand driven extension system. The implementation of this policy was envisioned to contribute towards improved transfer of technology and management for higher agricultural sector productivity, a key prerequisite to poverty reduction and enhanced food and nutrition security.

Intensification of agricultural production and diversification into relatively more profitable and competitive livestock enterprises is one of the options to increase food production and reduce rural poverty. The IIC breeds have the potential of transforming livelihoods of populations in the developing countries of the world including Kenya. However, Kamau et al (2019) notes that only a few smallholder farmers have adopted the IIC technologies. In many areas of Kenya where rural livelihoods depend heavily on subsistence farming, using IIC breeds provides an opportunity to increased poultry productivity in smallholder agriculture and thus raise household income and reduce poverty.

Technological changes in agricultural production practices thus remains the main drivers of the sector's growth. However, given smallholders' limited access to productive resources, technologies, and markets, it is imperative to consider productivity improvements through provision of modern technologies. The KOPIA (Korea Project on International Agriculture) project in collaboration with the Meru County Government, department of livestock development embarked on a program to improve the performance of indigenous chicken value chains among small scale farmers by disseminating localized technologies and practices through the model village approach. The selected poultry farmers received training on poultry production practices, received day-old and month-old improved indigenous chicken chicks. Members of model villages were also provided with incubators to increase their access to improved indigenous chicks. In addition, social halls equipped with screens were constructed in the model villages which acted as meeting and learning centers.

The shift from free-ranging flocks to confined poultry operations was expected to increase the number of birds per farmer, facilitate the substitution of capital for labour, and lead to a significant increase in productivity. An impact evaluation will identify how the project addresses the main development problems in the area and quantify the impact of the project to the beneficiaries. Using data from participating (treatment group) and non-participating (control group) farmers in the model villages, this knowledge gap was addressed by assessing the impact of KOPIA project on the income of small holder indigenous chicken farmers in Meru County. The fact that low adoption of new technologies

and innovations has been identified as a contributing factor to the decline in agricultural productivity means that although Kenya has a well-structured agricultural research system, small scale farmers will still experience low incomes.

According to the Meru County Socio Economic Indicators baseline survey (2016), 89% of the households in Meru County practice agriculture while 63% of all enterprises owned are in the agriculture sector. The 2019 Kenya Population and Housing Census in 2019 estimates that over 89% of the estimated 426,360 households in Meru keep chickens or some other poultry, making the local chicken a main source of income and employment. Dilley et al. (2021), reported that a majority of those in Meru County envision a future which involved some agricultural activity with most indicating that they saw their imagined future involving a mix of activities. Thus, productivity change using existing technologies with better input allocation or modern technologies with available inputs would contribute to economic sustainability. The Meru County Government Vision 2040 (Meru County Government, 2019) recognizes that to improve smallholder farm productivity and increase farm households' incomes, it is important to transform the sector into a profitable, commercial oriented and competitive economic activity. Plans for the livestock sector includes disease control with emphasis on prevention, reducing the cost of production to have a competitive advantage, commercialization of livestock farming, improved breeding, improvement of feed, support of processing and marketing, supporting farmers with agricultural equipment and with subsidized inputs.

1.1 Statement of the Problem

The improved indigenous chicken breeds have the potential of transforming livelihoods of populations in the developing countries. They provide an opportunity to increase poultry productivity in smallholder agriculture and thus raise household income and reduce poverty. However, given smallholders' limited access to productive resources, technologies and markets, it is imperative to consider productivity improvements through provision of modern technologies. The KOPIA project in collaboration with the Meru County Government embarked on a program to improve the performance of indigenous chicken value chains among small scale farmers. The aim was to increase the number of birds per farmer, facilitate the substitution of capital for labour which was expected to significantly increase in productivity and income. However, the impact of the intervention on the welfare of the beneficiary smallholder poultry farmers in Meru County is not well understood. Using data from participating (treatment group) and non-participating (control group) farmers in the model villages, this knowledge gap was addressed by assessing the impact of KOPIA project on the income of small holder indigenous chicken farmers in Meru County.

1.2 Research objective

The aim of this paper aimed at quantifying the impact of the KOPIA programme on poultry farmers' income in Meru County, Kenya

II. LITERATURE REVIEW

2.1 Theoretical Review

This study was based on the rational choice theory proposed by economist Adam Smith in 1776. The theory assumes that decision to participate in a project is motivated by expected gains. Farmers are rational consumers of new technologies and will adopt technologies in anticipation of increased productivity and will therefore choose the most preferred alternative. According to Neumann and Morgenstern (2007) preference of new technology will be made if its expected utility exceeds that of the traditional technology. Hence the decision to participate in the KOPIA project activities will be realized if the expected utility for participating is greater than the utility for not participating.

Impacts evaluations are done to answer cause and effect questions, which evaluate the outcome and assess the differences an intervention makes in an outcome (Rosebaum & Rubin, 1983). Since the outcome of the same individual cannot be simultaneously obtained with and without the program, impact assessment establishes with as much certainty as possible, whether or not an intervention produces its intended effects. There are two approaches to study the impact of a given project: the 'before and after' and the 'with and without' approaches. Before and after analysis compares the performance of key variables during and after the program, with those prior to the implementation of the program. With and without comparisons compares the behavior in the key variables in a sample of program beneficiaries, with their behavior in non-program group (a comparison group). This is an approach uses the experiences of the comparison group as a proxy for what would otherwise have happened in the program beneficiaries. These approaches use statistical methods to evaluate whether there is a significant change in some essential variables over time.

Although impact evaluation has taken different meanings, this study considered it as an assessment of the impact of an intervention on final welfare. According to White (2006) impact evaluation is concerned with establishing the counterfactual, i.e., the difference the project made (how indicators behaved with the project compared to how they would have been without it). The appropriate counterfactual is most usually defined with reference to a control group, which has to be identified in a way in which avoids selection bias, meaning the use of either experimental or quasi-

experimental approaches. An evaluation of impact is therefore important to comprehend the effects of participating in the KOPIA programme on the recipients' increased income.

2.2 Empirical Review

2.2.1 Assessing the Impact of KOPIA Project

Impact evaluation is important for determining whether a program is making a difference to people, groups, organizations or communities (Streatfield & Markless, 2009) Thus, the approach was used to determine the effect of KOPIA project on income for poultry farmers in Meru County, Kenya. Literature identifies three main kinds of impact evaluation designs. These are experimental, quasi-experimental and non-experimental. In experimental or randomized control design method selection into the treatment and control groups is random within some well-defined set of people. In this case there should be no difference between the two groups besides the fact that the treatment group had access to the program. Non-experimental or quasi-experimental design methods are used to carry out an evaluation when it is not possible to construct treatment and comparison/control groups through experimental design. These techniques generate comparison groups that resemble the treatment group, at least in observed characteristics. The econometric methodologies include difference in difference methods, reflexive comparisons, instrumental variables methods and matching methods (Baker, 2000).

Evaluating program effectiveness without a randomized control is a frequent necessity in most public programmes. Matching techniques have gained prominence in impact evaluations with the most widely used type of matching is propensity score matching (PSM), in which the comparison group is matched to the treatment group on the basis of a set of observed characteristics in the form of a propensity score. The propensity score is the predicted probability of participation in an intervention given observable characteristics. Propensity-score matching is a non-experimental method for estimating the average effect of social programs (Rosenbaum & Rubin, 1983; Heckman *et al.*, 1998). The nature of treatment may be very diverse which according to Barbara, (2009) and Ali & Abdulai, (2010) makes matching the best available method for selecting a matched comparison group which 'looks like' the group of interest. PSM was thus used in the study.

To analyse the effect of participation in the KOPIA project on income, Propensity Score Matching (PSM), a quasi-experimental approach was used to analyze the impact of the project in Meru County. According to Kono and Takashi (2010) and Stuart (2010), Average Treatment Effect (ATE) and Average Treatment Effect on the Treated (ATT) can be used to directly measure the impact of participating in the project activities on the target group. The assumption will be that those who participated and those that did not participate in the KOPIA project could have the same income except for the intervention of the project. The impact of treatment for individual i , noted δ_i , is defined as the difference between the potential outcome in case of treatment and the potential outcome in absence of treatment (Hulme, 2000)

$$\delta_i = Y_{1i} - Y_{0i} \quad (1)$$

Y_{1i} and Y_{0i} are mutually exclusive because the same individual cannot participate or not participate at the same time (Heckman *et al.*, 1997). In general, the evaluation seeks to estimate the mean impact of a program, obtained by averaging the impact across all the individuals in the population. This parameter is known as ATE:

$$ATE = E(\delta) = E(Y_1 - Y_0) \quad (2)$$

Where $E(\cdot)$ represents the average (or expected value).

ATT measures the impact of the program on those individuals who participated:

$$ATT = E(Y_1 - Y_0 | D = 1) \quad (3)$$

Where; Y is the income from chicken in a year, Y_1 is the observed income for the treated, and Y_0 is the counterfactual. The expected value of the ATT is defined as the difference between expected outcome values with and without treatment for those who participated in treatment.

The treatment sample refers to those who have participated in the KOPIA project activities as members of poultry model villages. A group of those who did not participate in the project activities served as the control group to control for selection bias. The purpose of matching was to estimate the counterfactual outcome and correct for selection biases created by non-random sampling of those who have participated in the project. To estimate ATT based on propensity scores, alternative matching methods to assess the effect of the project will be compared; Nearest neighbor matching, Kernel matching, and Caliper matching methods.

A Logit model was applied to estimate the propensity scores of participating in the project. The Binary Logit Regression model was used to examine the determinants of participation in KOPIA project activities by poultry farmers. The logit model was used for the binary outcomes of dependent variable. The dependent variable was the choice by farmers either to participate in the KOPIA project or not (Participants and non-participants). Score of 1 was given if yes and 0 otherwise.

$$\ln\left(\frac{p_i}{1-p_i}\right) = pr(D_i = 1) = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n + e_i \quad (4)$$

Where;

$\ln \left(\frac{p_i}{1-p_i} \right)$ is the log of odds ratio = LOGIT

$b_0, b_1, b_2 \dots \dots \dots b_n$ are the logit coefficients to be estimated.

$x_1, x_2 \dots \dots \dots x_n$ are the independent variables and e_i is the error term.

The Logit model was used to estimate project participation as a function of the observable characteristics.

2.2.2 The KOPIA Project in Meru County

The South Korean Rural Development Administration (RDA) through Korea Program on International Agriculture (Now Korean Programme for International Cooperation in Agricultural Technologies-KOPIA) supported an Indigenous Chicken Technical Cooperation Project (TCP) in Meru County. The project's main aim was contributing to raising the food security, nutritional status and wealth of the Meru County smallholder households through increased production in terms of number of eggs laid per chicken, number of chickens growing to maturity per household, amount of meat gained per chicken in the shortest time and the number of chickens sold. The project also envisaged to realise increased profits to the farmers due to increased access to financial access and strengthened marketing strategies.

The Meru-KOPIA indigenous chicken project targeted regions in the county that predominantly receive low and poorly distributed rainfall leading to frequent crop failure. The indigenous chicken is one of the main sources of income and employment. The village model chicken production and marketing-based outreach project promoted the resilient improved indigenous chicken which thrives under the low input-output system in selected smallholder households in Meru County Kenya. The project is implemented by County Government of Meru department of Agriculture, Livestock development and Fisheries (MERU-ALF) in collaboration with the KOPIA Center in Nairobi, Kenya.

The selection of the model villages beneficiary households was done through community participatory processes involving the local national government administration, the county government leaders, local churches and support groups, non-state actors' representatives, the department of Agriculture and Livestock development and the local community leaders. In a bid to reorganize and strengthen the participating farmers into cohesive groups, the implementation approach involved formation of four (4) smaller common interest groups (CIGs) in each of the selected model villages. Social cohesiveness, geographical distribution, poverty and vulnerability indices, willingness to participate in the chicken production and gender considerations were critical in the selection of the participating households.

In order to enhance chicken productivity at the farm level and hasten adoption of innovations, the project procured and distributed improved indigenous chicks amongst the model village beneficiaries. Beneficiaries were also supported with additional amenities to improve poultry production including a social hall fitted with screens and furniture, borehole, hatchery unit, incubators, power generators, motorcycle and office equipment. The farmers in the model villages were capacity built on skills and knowledge in chicken production and marketing. A detailed training curriculum was developed by the technical department of Meru-ALF covering topics in chicken production systems, feeding and nutrition, record keeping, ration formulation, incubation and brooding, health management, entrepreneurship, chicken housing and equipment, marketing, group formation and dynamics, management, leadership and financial literacy

The study will provide empirical evidence of the impact of the KOPIA programme on poultry farmers' productivity and income. Therefore, this paper aims at quantifying the impact of the KOPIA programme among smallholder indigenous chicken farmers in Meru County of Kenya. The analysis will highlight the scale of the opportunity of access to technologies and evaluate its scope to increased income from agricultural production. The remainder of the paper is organized as follows: Section 2, explains the materials and methods applied in data collection and analysis section 3 presents the results and discussion from data analysis and section 4 presents the conclusions and policy implications.

III. METHODOLOGY

3.1 Study Area

The study was carried out in Meru County, Kenya. Meru County is an agricultural county located on the eastern side of Mt. Kenya with a total of 423,848 households out of which 64.7% are farming households (KNBS, 2021). According to Republic of Kenya (RoK) (2013), Meru has an altitude that lies between 2230 and 2900m above the sea level, lies between longitudes 38° East and 37° West and also along the equator at latitudes 0°6' North and 0°1' South. It is made up of 45 Wards and 9 Sub- Counties, namely; Tigania West, Tigania East, Igembe Central, Igembe North, Igembe South, Imenti North, Imenti South, Central Imenti, and Buuri (RoK, 2013). Meru County is characterized by four main agro-ecological zones; the upper highlands, the lower highlands, the upper midlands and the lower midlands which is a semi-arid area. (Jaetzold et al., 2007).

Livestock rearing is a common enterprise in Meru, with a population of 274,081 livestock farming households out of which 71% are subsistence livestock farmers (Ministry of Agriculture, Livestock and Fisheries, 2019). Livestock constitute 52% of the households' income (Mwendia et al., 2020), an indication that it is a key income earner for families in the area. Meru is the leading producer of indigenous chicken in Eastern Kenya, with a population of over 1.3 million IC (Ministry of Agriculture, Livestock and Fisheries, 2018), with production concentrated among farmers in Tigania West. Although the average farm size differs from one agro-ecological zone to another, the average land holding size per household is 1.8 ha (County Government of Meru, 2018) which according to FAO definition (Khalil et al., 2017) are considered as small scale producers.

3.2 Research Design

A descriptive cross-sectional survey research design was adopted to achieve the purpose of this study. This design enabled the researcher to make inferences and generalizations about the population of interest.

3.3 Target Population

The project had been implemented in Meru County where the area of coverage for intervention was done through public participation of the policy makers depending on various factors among them being suitable agro ecological zone, areas who have minimal or little support from other development partners. A total of 400 small scale farmers from Mbaria, Ng'onyi, Ntalami and Kangeta model villages who participated in the KOPIA project constituted the study population.

3.4 Sampling and Sample Size

The 4 model villages were purposively selected for the survey and a list of the 400 participating farmers from the model villages was used to randomly select a sample of 150 farmers. In addition, 100 non-participating farmers were selected from the four model villages using simple random sampling technique to act as a control group.

3.5 Data Collection

The survey was carried out between September and October, 2022 and captured data for the latest production cycle. The data used for the study was cross-sectional obtained from household survey at farm level conducted by well-trained enumerators and administered through structured questionnaires.

Table 1

Description of Variables used for Impact Evaluation in Meru County

Variable	Type	Measurement
Income	Continuous	Kenya Shillings
Mbaria	Dummy	1 if farmer is located in Mbaria, 0 otherwise
Ng'onyi	Dummy	1 if farmer is located in Ng'onyi, 0 otherwise
Ntalami	Dummy	1 if farmer is located in Ntalami, 0 otherwise
Age	Continuous	Years
Experience	Continuous	Years
Off-farm income	Dummy	Yes=1, No=0
Occupation	Dummy	1 if farming is the main occupation, 0 otherwise
Cash crop enterprises	Continuous	Number
Livestock enterprises	Continuous	Number
Food crops enterprises	Continuous	Number
Eggs sold	Continuous	Number
Hens sold	Continuous	Number
Cocks sold	Continuous	Number
Eggs per hen	Continuous	Number

IV. FINDINGS & DISCUSSION

4.1 Response Rate

A 100% response rate was achieved by having 150 completed questionnaires that were collected from farmers who were participating in project activities. 86% response rate was achieved from the targeted 100 non-participating farmers.

4.2 Characteristics of Participants and Non-Participants of KOPIA Project Activities

The differences in the characteristics of participants and non-participants with test of significance in their differences are presented in Table 2. T-tests were carried out for continuous variables and chi-square test for categorical variables.

Table 2

Differences in Characteristics of Participants and Non-Participants of KOPIA Project Activities (sample mean)

	Participating	Non-Participating	Difference	t/ χ^2
Mbaria	0.23	0.31	-0.08	-1.35
Ngonyi	0.19	0.34	-0.15*	-2.63
Ntalami	0.33	0.07	0.3*	4.778
Age	50.01	44.74	5.27*	3.24
Experience (Years)	15.53	11.09	4.44*	3.26
Off-farm income (Yes=1)	0.75	0.81	-0.06	-1.07
Occupation (Farming=1)	0.63	0.7	-0.07	-1.06
Cash crop enterprises (No.)	0.23	0.23	0	0.01
Livestock enterprises (No.)	0.56	0.34	0.22*	2.62
Food crop enterprises (No.)	2.08	1.98	0.1	0.59
Eggs sold (No.)	197.6	194.49	3.11	0.05
Hens sold (No.)	17.17	6.93	10.24*	4.10
Cocks sold (No.)	14.68	7.7	6.98*	3.01
Eggs per hen (No.)	140.4	44.5	96.0*	3.01

*Significant at 10%, **significant at 5% and *** significant at 1%;

The t tests show that the participating and non-participating farmers differ significantly with respect to age, experience in poultry farming, number of livestock enterprises, number of hens and cocks sold and annual per hen egg production. Generally, participating farmers had more experience in poultry farming, had more livestock enterprises, sold more hens and cocks and higher per hen egg production. According to Chege *et al.* (2019), technology transfer aims to improve the human resources and production capacity for long-term economic development. Thus, the participating farmers reported a significantly number of eggs produced per hen, the number of cocks sold and the number of hens sold.

4.3 Impact of Participating in KOPIA Project on Income

To assess the impact propensity score matching (PSM) was applied. Since the purpose was to compare the outcomes for those participating and with those not participating, Aditiya *et al.* (2019) suggest that the estimate can be constructed from a Probit or Logit model. The results of the initial step in PSM used in estimating the propensity scores (which employs a Logit regression) are shown in Table 3.

Table 3

Maximum Likelihood Estimates of the Logit Regression used in Estimating the Propensity Scores

Variable	Coef.	SE	z	P value
Mbaria	1.8514**	0.901	2.05	0.040
Ngonyi	1.7297*	0.974	1.78	0.076
Ntalami	4.1842***	1.002	4.18	0.000
Age	0.0234	0.029	0.8	0.426
Experience	0.0559	0.043	1.3	0.192
Off-farm income	-0.2676	0.789	-0.34	0.735
Occupation	-0.1447	0.606	-0.24	0.811
Cash crop enterprises	0.6235	0.640	0.97	0.330
Livestock enterprises	0.9910*	0.546	1.82	0.069
Food crops enterprises	-0.2519	0.331	-0.76	0.447
Eggs sold	-0.0017***	0.000	-2.6	0.009
Hens sold	0.1040*	0.053	1.95	0.051
Cocks sold	0.0058	0.044	0.13	0.894
Eggs per hen	0.0191***	0.006	3.05	0.002

*Significant at 10%, **significant at 5% and *** significant at 1%;

Pseudo R² = 0.388; P value = 0.000

The likelihood ratio test of goodness of fit indicates that the model fits the data well (p value =0.000). The results also show that seven independent variables were found to be significant in explaining the farmers' participation in the KOPIA project. Hence individuals participating in the project differ significantly from the non-participants with respect to observable characteristics suggesting that there is self-selection. Comparing the two groups as they are would have resulted in biased estimates and thus the need to correct for selection bias through the use of propensity score matching.

With high production costs and as agricultural marketing becomes competitive in terms of quantity and quality, smallholder farmers increasingly encountered the problems regarding the production and distribution of agricultural products. The results show that livestock enterprises, egg production per hen, number of eggs sold and number of hens sold significantly influenced participation in the project. The results confirm the findings by Palee et al (2024) who reported that production income influenced the participation in agricultural projects. The findings confirm a study by Chege et al. (2019) which found that engaging in livestock enterprises influenced participation in agricultural technologies.

The impact of participating in the KOPIA project was computed using four matching algorithms namely, Kernel based matching (KBM), nearest neighbor matching 1 (NNM1), nearest neighbor matching 5 (NNM5) and Caliper based matching (KBM) as shown in Table 4. Nearest Neighbor 1 and 5 refers to matching algorithm that compares propensity score of a participant with the non-participant who has a similar or closest propensity score during impact assessment. It was preferred since all treated matches found a match. Kernel Matching was preferred to improve the quality of matching since it matched all the participants with a weighted average of all non-participants with weights that were inversely proportional to the distance between the propensity scores of the participants and non-participants. The main purpose of a matching procedure is to reduce selection bias by increasing the balance between the treatment and control groups. The outcome variable was the annual income from poultry in Kenya Shillings (Kshs).

Table 4
Impact of Participating in the KOPIA Program on Household Income

Matching algorithm	Outcome Variable	Treated	Controls	Difference	Std.Err	T-stat
Kernel Based Matching	ATT	116326.2	46418.09	69908.07	19507.01	3.58**
	ATU	23009.57	105771.90	82762.34		
Caliper Based Matching	ATT	115322.2	48705.42	66616.81	20180.09	3.3**
	ATU	22472.45	124771.40	102298.98		
Nearest neighbor Matching (1)	ATT	115322.2	48705.42	66616.81	20180.09	3.3**
	ATU	22472.45	124771.40	102298.98		
Nearest neighbor Matching (5)	ATT	115322.2	33647.47	81674.76	18981.61	4.3**
	ATU	22472.45	89011.08	66539.35		

*Significant at 10%, **significant at 5%, ***significant at 1%

Notes: ATT: Average Treatment effect of the Treated; ATU: Average Treatment effect of Untreated; ATE: Average Treatment Effect; Propensity Score: Refers to the probability that a household might be exposed to the treatment (Participation in KOPIA project).

The results indicate that, participating in KOPIA project had a positive and significant impact on the incomes of the small holder poultry farmers at the 5 percent level. The impact for these farmers is an increment in the average income from poultry of Kshs 69,908, Kshs 66,616, Kshs 66,616 and Kshs. 81,674 using KBM, CBM, NNM (1) and NNM (5) matching algorithms respectively which are significant at 5 percent. It can therefore be concluded that the impact of participating in KOPIA program helped the farmers to increase their income from poultry production. The 95% confidence level for all the matching methods imply that, assuming no selection bias, average annual income from poultry for participants was significantly higher than for the non-participants.

The density distribution of the propensity scores for participants and non-participants is shown in Figure 1. The bottom half of each graph shows the propensity score distribution for the non-treated, while the upper-half refers to the treated individuals. The y-axis (density/proportion) indicates the frequency of the propensity score distribution while the x-axis (propensity score) represents the estimated probability of a participant being in the treated group, based on their baseline characteristics, with scores ranging from 0 to 1. It presents the covariates' means, their t-test of differences in means as well as the percentage bias before and after matching.

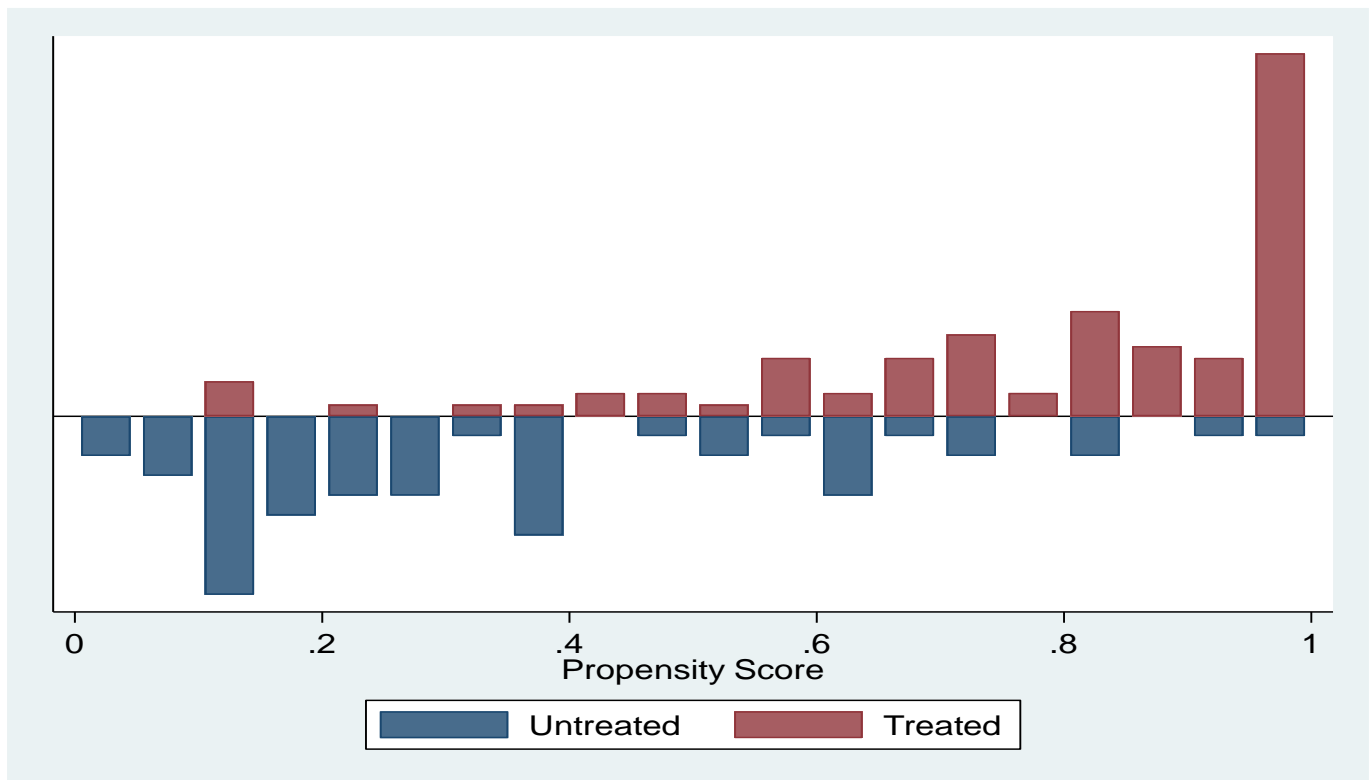


Figure 1

Propensity Score Distribution and Common Support for Propensity Score Estimation

Visual analysis of the density distribution of the propensity scores suggests that there is a high chance of getting good matches. All the treated and the untreated individuals were within the region of common support indicating that all treated individuals have corresponding untreated individuals. This indicates a successful propensity score model, allowing for a less biased estimation of the treatment or participation effect.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The main objective of this study was to determine the effect of participating in KOPIA project on income of small scale chicken farmers in Meru County. Using data from smallholder poultry farmers from participating villages in Meru County, Kenya, the study employed propensity score matching (PSM) to estimate the additional income that can be attributed to participation. Seven variables were found to be significant and include number of livestock enterprises, number of eggs per hen per year, the number of hens sold in a year, and residing in Mbaria, Ng'onyi, and Ntalami. The estimated average treatment effects (ATT) obtained through PSM method shows that participation yields positive and significant effects on the farmers' income. Given the findings, we point out that participating in KOPIA program is likely to improve farmers' income and therefore more farmers should be part the village model.

5.2 Recommendations

To enhance the impact of the KOPIA project and other agricultural development projects in the future, attention should be given to improving market access in order to increase benefits from increased output. For sustainability, assisting farmers to convert their groups to farmer cooperatives will not only enable them to get benefits of collective marketing, but also access credit for enterprise improvements and expansion. Farmer training should be on going in order to meet the continuous need for new knowledge, with emphasis on leadership and group dynamics.

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