# IMPACT OF CONTRACT FARMING ON SMALLHOLDER POULTRY FARMERS' INCOME IN KENYA

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**Abstract**

*Contract farming is a form of vertical coordination largely aimed at correcting the market failure associated with spot markets that arise due to imperfect information. However the impact of contract farming on the welfare of smallholder farmers in Kenya is not well understood. While some authors have argued that contact farming improves access to ready markets by smallholder farmers, other studies have suggested that contract farming lowers the incomes of smallholder farmers because the contractors wield greater market power over the farmers. Consequently, it is seen as a blessing by some and a necessary evil by others. This study uses a propensity score matching technique to shed light on the impact of contract farming on smallholder farmers. The study also examines the conditioners of participation in contract farming. It uses data collected from 180 smallholder poultry farmers stratified by participation in contract production. The study finds that, on average, contracted farmers earned more net revenue per bird compared to the independent farmers, by approximately 27 percent, and as such participating in contract farming could improve the welfare of these small holder poultry farmers. This finding suggests that getting smallholder commercial poultry farmers to participate in contract farming can help improve their welfare through increasing the net revenues from these birds and thereof incomes.*

**Key words**: Contract farming, smallholder farmers, impact, propensity score matching, poultry production, Kenya.

## 1.0 Introduction

Contract farming is defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (Eaton and Shepherd, 2001). The arrangement often involves the purchaser in providing a degree of production support through, for example, the supply of inputs and the provision of technical advice. For this arrangement to work the farmer commits himself to provide a specific commodity in quantities and at quality standards determined by the purchaser. The company on the other hand agrees to support the farmer's production and to purchase the commodity.

A fundamental feature of contract farming is the shifting of risk from producers to processors since it is a form of futures market. Production and price risks are important features of poultry farming. Risk sharing is one of the widely cited reasons for contracting. Numerous studies of contract farming emphasize risk reduction as a principal incentive for producers to enter in to contracts (Covey and Stennis, 1985). Much of the price risk is reduced, in contract farming, by the use of a predetermined price rather than the market price (Martinetz, 2005).

According to Strohm and Hoeffler (2006), contract farming has been gaining popularity in developing countries. Some of the enterprises where contact farming is widely used are French beans and other horticultural crops (Kenya and Ethiopia), fruits such as pineapples mangoes and passion fruits (Ghana), cotton (Zimbambwe) and poultry (Kenya). Indeed, much of the success in the 20 horticulture industry in Kenya, Zambia and Ethiopia has for instance been attributed to contract 21 farming with producer organization (Narrod et al, 2009; Okello and Swinton, 2007)

There are four models of contract farming arrangements namely centralized model, multipartite model, intermediary model and the informal model (Eaton and Shepherd, 2001). The centralized model involves a centralized processor and/or buyer procuring from a large number of small-scale farmers. The cooperation is vertically integrated and in most cases involves the provision of several services such as pre-financing of inputs, extension and transportation of produce from the farmer(s) to the buyers' processing plant. Multipartite contract farming model arises when a combination of two or more organizations (state, private agribusiness firms, international aid agencies or non-governmental organizations - NGOs) work together to coordinate and manage the cooperation between buyers and farmers.

An intermediary model shows many characteristics of a centralized model with the difference that they act as an intermediary on behalf of another firm. Normally, the intermediaries organize everything on behalf of the final buyer starting with input supply, extension service, payment of the farmers and final product transport. Handling several thousands of out growers involves significant management effort and therefore it might be economically attractive for a buyer to outsource this task to an intermediary. Lastly Informal arrangements involve casual oral agreements between contracting parties and regularly repeated marketing transactions, but are characterized by the absence of written contracts or equally binding and specifying documents

While contract farming is widespread in Africa and many other developing countries, there are conflicting views on its impact on the welfare of smallholder farmers. Some authors argue that contract farming is beneficial to the small holder farmers since it enables farmers to access ready markets and also to access global markets (Key and Rusten, 1999; Warnings and Key, 2002; Gulati *et al*, 2005; Minot, 1986; Minot and Roy, 2006; Minot *et al*, 2009). Such authors also argue that contract farming enhances the income of farmers which they attribute to the economies of scale enjoyed in contract farming. On the other hand other authors argue that contract farming is a means of exploiting farmers by the large agribusiness firms due to the unequal bargaining power (Little and Watts, 1994; Singh, 2002). They criticize contract farming on the basis that most of the contractual terms are too costly for smallholder farmers to comply with and that most large firms break the contractual terms at the expense of the smallholder due to unequal market power. Some other critics of contract farming (e.g. Guo et.al, 2005) argue that contract farming is only beneficial for large scale farmers and that it only serves to push smallholder farmers out of the market and could even lead to rural inequality and entrench poverty among the rural smallholder farmers.

The two contradicting views make contract farming appear as a necessary evil in the production and marketing of certain agricultural commodities. It is necessary because it is often a solution to the problem of endemic market failures in developing countries. Yet, it is evil because it may be an avenue for some large agribusiness firms to exploit the small scale farmers. However the question still remains as to whether contract farming indeed improves the welfare of the farming communities. However, the welfare impacts of contract farming on the incomes of smallholder farmers especially in developing countries remain unknown. This study evaluates the welfare impacts on contract farming on the incomes of smallholder poultry farmers in Nakuru County, Kenya. The study employs a Propensity Score Matching (PSM) model that uses data from a survey of 180 farmers selected using a multi-stage sampling technique.

Theoretically, farmers participate in contract production as a way of hedging against risk and resolving other idiosyncratic risks (Rehber, 1998; Martinetz, 2005; Okello and Swinton, 2007). The nature of market failure however varies by geographical location and the nature of the market. Development literature identifies high transaction costs and asset poverty as major drivers of market failure (Barrett, 2008). This study addresses two objectives. First, it examines the factors affecting participation in commercial poultry contract production, after controlling for risk. Second, the study uses Propensity Score Matching (PSM) technique to examine the impact of contract farming on the incomes of smallholder poultry farmers. The study focuses on smallholder farmers producing poultry for Kims Poultry Care Center (KPCC), a large poultry firm located Nakuru, Kenya, under contract. KPCC is the only large poultry farm that works with smallholder farmers in Kenya. Markets for both inputs and outputs tend to be thin, fragmented and hence generally fail for smallholder farmers in most developing countries (Narrod et al, 2009).

The rest of this paper is organized as follows. Section 2 provides a brief review of commercial poultry production in Kenya to provide context for the study. This is followed by a presentation of the study approach in Section 3. Section 4 presents the results of the PSM model. Finally, Section 5 concludes and discusses policy implications.

## 2.0 Study context

Commercial poultry production is concentrated in the urban centers of Nairobi, Mombasa, Nakuru, Kisumu and Nyeri where ready urban markets are available. This has led to the growth of commercial hatcheries located in the peri-urban areas, which sell hybrid broiler and layer chicks to commercial farmers (Nyaga, 2007). Kenya has one of the most well-developed commercial poultry industries in Africa (Nyaga, 2007). Among the commercial poultry producing areas in Kenya, only Kiambu and Nakuru counties have some form of contractual arrangement. The poultry contracting firm in Kiambu is Kenchic Limited that deals exclusively with medium and large scale farmers. On the other hand the contracting firm in Nakuru County, Kims Poultry Care Centre, works with smallholder farmers. This study focuses on commercial poultry production by smallholder farmers in Nakuru County, Kenya. Nakuru County was chosen because it had smallholder contracted farmers.

Kims started contracting farmers in 1996 and has since then grown steadily. It works with farmers within a radius of 60km around Nakuru town to ease logistical costs. Strohm and Hoeffler (2006) indicate that the Kims deals with three categories of farmers namely, small-scale keeping an average of 100 to 500 birds, medium scale with an average of 500 to 1000 birds and large scale farmers with over 1000 birds on average. Kims Poultry Farm gets its parent stock of 6000 birds every 2 to 3 months from Kenchic Ltd and hatches approximately 20,000 to 30,000 day-old chicks per week. It sells 60 percent of its day old chicks to contract out growers and 40 percent to contracted agents who distribute to poultry farmers. It therefore does not deal directly with farmers.

Nakuru County is a cosmopolitan region in the Rift Valley province with a population of 471, 514 people. The major drivers of the economy in the County are agriculture and tourism. According to Republic of Kenya (RoK) (2005) and Nyaga (2007) the County has high poverty levels (ranging from 41 percent in the urban areas to 45 percent in the rural areas) and high unemployment levels (approximately 15 percent). Poultry is production is one of the leading agricultural enterprises in the County. The processed chicken and eggs produced in the county feed into the tourist hotels with the rest being sold to other cities in Kenya and in the East Africa region (Okello *et al*, 2010).

## 3.0 Study Approach

### *3.1 Theoretical framework*

Impact assessment establishes with as much certainty as possible, whether or not an intervention produces its intended effects (African Impact Evaluation Initiative (AIEI), 2010). There are two approaches to study the impact of a given project. These are 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. This approach uses statistical methods to evaluate whether there is a significant change in some essential variables over time. The approach often gives biased results because it does not take in to account the effect of the confounding factors on the change. 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.

Impact evaluations typically rely on econometric and statistical models. There are three main kinds of impact evaluation designs. These are experimental, quasi-experimental and non-experimental which are respectively associated with control groups, comparison groups, and non-participants. Impact Evaluation (IE) rigorously measures the impact that a project has on beneficiaries. It typically does this by comparing outcomes between beneficiaries and a control group (African Impact Evaluation Initiative (AIEI), 2010*)*.

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 (in expectation) 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, through econometric methodologies, which include difference in difference methods, reflexive comparisons, instrumental variables methods and matching methods (Baker, 2000).

More recently matching techniques has gained prominence in impact evaluations (Ali and Abdulai, 2010). In matching methods (also known sometimes as constructed controls), an individual from comparison is matched with one from the treatment group and difference in outcome variable of interest in the intervention computed (Caliendo and Kopeinig, 2005). The most widely used type of matching is propensity score matching, 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. Under this approach the closer the propensity scores for the treatment and the control are the better the match. A good comparison group comes from the same economic environment and was administered the same questionnaire by similarly trained interviewers as the treatment group (Baker, 2000).

Propensity-score matching is a non-experimental method for estimating the average effect of social programs (Rosenbaum and Rubin, 1983; Heckman *et al*., 1998). The method compares average outcomes of participants and non-participants, conditional on the propensity score value. The parameter of interest is the average treatment effect whose computation is based on the strong identification conditions. Propensity score matching has become an extremely popular evaluation method. Both in the academic and applied literature the amount of research based on matching methods has been steadily growing. Its application in the evaluation of agricultural interventions has grown tremendously in last few years (Ali and Abdulai, 2010; Becceril and Abdulai, 2010). It has also been widely applied in evaluating labor market policies and other diverse fields of study (see e.g. Dehejia and Wahba (1999) or Heckman *et al*. (1997)). Its popularity stem from the fact that it can be applied in any situation where one has a group of treated individuals and a group of untreated individuals. The nature of treatment may be very diverse .Some authors have therefore argued that matching is the best available method for selecting a matched (or re-weighted) comparison group which 'looks like' the (treatment) group of interest (Barbara, 2009; Ali and Abdulai, 2010; Becerril and Abdulai, 2010).

In this study PSM was used to evaluate the impact of contract farming on net income from poultry. Therefore the treatment is participating in contract production. According to Heckman (1979) impact of an intervention is essentially an estimation of a treatment effect in policy analysis. However, change in an outcome of a treatment is often a function of multiple endogenous and exogenous factors. Often, the problem arises in identifying part of the change in the outcome variable for the target population due to treatment. This problem arises due to the difficulty of observing the counterfactual corresponding to any change induced by a treatment. Yet it is necessary to observe the counterfactual if the impact is to be assessed. Given that the decision of households to participate or not to participate in the treatment may be associated with the net benefits from participation, the issue of self-selection becomes extremely crucial.

Following Heckman (1979) the impact of participation in contract farming on household income (Y) can be expressed as a function of explanatory variables ($X_i$) and a participation dummy variable (R) specified as;

$Y = \beta X_i + AR_i + \mu_i$ …………………………………………………………… (1)

Where $R_i$ =1 for contracted farmers and 0 for independent farmers.

$\mu_i$ is the error term, β and $A$ are coefficients.

Whether farmers participate in contract farming or not is dependent on the characteristics of farmers and farms, hence the decision of a farmer to participate is based on each farmer's self-selection instead of random assignment.

Assuming a risk-neutral farmer, the index function to estimate participation in contract farming can be expressed as:

$R_i^* = \gamma X_i + e_i$ ……………………………………………………………………….. (2)

Where $R_i^*$ is a latent variable denoting the difference between utility from participating in contract farming $U_{iA}$ and the utility from not participating ($U_{iN}$). The farmer will participate in contract farming if $R_i^* = U_{iA} - U_{iN} > 0$. The term $\gamma X_i$ provides an estimate of the difference in utility from participating in contract farming ($U_{iA} - U_{iN}$), using the household and farm-level characteristics,$X_i$ as explanatory variables, while $e_i$ is an error term. In estimating equations (1) and (2), it should be noted that the relationship between participating in contract farming and the outcome (such as income) could be interdependent. Thus, participating in contract farming can increase output and as such richer households may be better disposed toward participating in contract farming. Thus, treatment assignment is not random, with the group of farmers being systematically different. Specifically, selection bias occurs if unobservable factors influence both the error terms of the income equation, $\mu_{i,}$ and that of the participation choice equation,$e_i$ thus resulting in correlation of the error terms of the outcome and participation choice specifications (Green, 2003). In that case, estimating equation (1) with ordinary least squares will lead to biased estimates.

Several strategies have been employed in addressing the problem of selection bias above. Some studies have employed the Heckman two-step method to address selection bias, when the correlation between the two error terms is greater than zero. However, the approach depends on the restrictive assumption of normally distributed errors. Another way of controlling for selection bias is to employ instrumental variable approach (IV).

A major limitation of the instrumental variable approach is the difficulty in finding and identifying instruments in the estimation. In addition both OLS and IV procedures tend to impose a linear functional form assumption implying that the coefficients on the control variables are similar for adopters and non-adopters (Ali and Abdulai 2010). They further add that this assumption may not hold, since the coefficients could differ. Unlike the parametric methods mentioned above, propensity score-matching requires no assumption about the functional form in specifying the relationship between outcomes and predictors of outcome. Due to the shortcomings of the two methods discussed above, propensity score matching which is a non-parametric method, first proposed by Rosenbaum and Rubin (1983) is used as a treatment effect correction model to reduce self selection bias.

To evaluate the impact of participation in poultry contract farming on income all observable characteristics have to be the same between the contract farmers which in this case is the treatment and the non-contract farmers which in this case will be the control. The expected treatment effect of contract participation or Average Treatment effect on Treatment (ATT) is the difference between the actual income and the income if they did not participate in contract farming. This is given as;

$$ATT = E(Y_{1i} - Y_{0i} \ / \ P_i = 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where $Y_{1i}$ denotes income when the *i-th* farmer participates in contract, $Y_{0i}$ is the income of *i-th* farmer when he does not participate in contract, and $Pi$ denotes the contract participation, 1=participate, 0=otherwise. ATT is also called conditional mean impact. The mean difference between observable and control is written as;

$$D = E(Y_1/P_i = 1) - E(Y_0 \ / \ P_i = 0) = ATT + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

where ε is the bias, also given by:

$$\varepsilon = E(Y_0 \ / \ P_i = 1) - E(Y_0 \ / \ P_i = 0) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

The true parameter of ATT is only identified if the outcome of treatment and control under the absence of contract are the same. This is written as:

$$E(Y_0 \,/\, P_i = 1) = E(Y_0/P_i = 0) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

*3.2 Empirical methods*

To assess the determinants of participating in contract farming a Logit model was used. The dependent variable for this case is not continuous instead it is binary as such either Logit or Probit can be used. Both the Logit and Probit models estimate parameters using maximum likelihood. Probit assumes normally distributed error term whereas the Logit model assumes a logistic distribution of the error term. The Logit model is often preferred due to the consistency of parameter estimates associated with the assumption that error term in the equation has a logistic distribution (Ravallion 2001, Baker 2000). Therefore the Logit model was used to estimate the probability of contract participation assigned to socio- economic characteristics. The dependent variable takes a value of 1 for contract participation and 0 for non-contract participation.

To address the second objective which is to assess the impact of contract participation on income propensity score matching will be was used. Baker (2000) gives the steps involved in applying propensity score matching. First the propensity score is estimated using a discrete choice model. To estimate the participation probability, Logit model with maximum likelihood method is often preferred due to the consistency of parameter estimation associated with the assumption that error term in the equation has a logistic distribution (Baker 2000, Ravallion 2001). Caliendo and Kopeinig (2005) also note that the Logit model which has more density mass in the bounds could be used to estimate the propensity score $p(X)$.

In the second step matching algorithm is selected based on the data at hand after undertaking matching quality test. Matching is a common technique used to select control subjects who are matched with the treated subjects on background covariates that the investigator believes need to be controlled. In this study nearest neighbor matching (NN), radius matching (RM) and kernel based matching (KBM) methods were used. Basically, these methods numerically search for “neighbours” that have a propensity score for non-treated individuals that is very close to the propensity score of treated individuals. NNM method is the most straight forward matching method. It involves finding, for each individual in the treatment sample, the observation in the non-participant sample that has the closest propensity score, as measured by the absolute difference in scores (Baker, 2000; Caliendo and Kopeinig 2005).

The KBM method is also a non-parametric matching method that uses the weighted average of the outcome variable for all individuals in the group of non-participants to construct the counterfactual outcome, giving more importance to those observations that provide a better match. This weighted average is then compared with the outcome for the group of participants. The difference between the two terms provides an estimate of the treatment effect for the treated case. Radius matching (RM) is a variant of caliper matching suggested by Dehejia and Wahba (2002). Applying caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within the caliper (‘propensity range’) and is closest in terms of propensity score (Caliendo and Kopeinig 2005). The basic idea of RM as a variant of caliper matching is to use not only the nearest neighbour within each caliper but all of the comparison members within the caliper. A benefit of this approach is that it uses only as many comparison units as are available within the caliper and therefore allows for usage of extra (fewer) units when good matches are (not) available.

In the third stage overlap condition or common support condition is identified. The common support or the overlap condition is an important condition while applying PSM. The common support is the area where the balancing score has positive density for both treatment and comparison units. No matches can be made to estimate the average treatment effects on the ATT parameter when there is no overlap between the treatment and non-treatment groups. In the fourth stage the treatment effect is estimated based on the matching estimator selected on the common support region.

Finally, sensitivity analysis is undertaken to check the strength of the conditional independence assumption. Sensitivity analysis can also be undertaken to check if the influence of an unmeasured variable on the selection process is so strong to undermine the matching procedure

(Ali and Abdulai, 2010). The sensitivity analysis was done by applying the Rosenbaum bound sensitivity test (r-bounds test). In addition to these, a major objective of propensity score estimation is to balance the observed distribution of covariates across the groups of participants and non-participants. The balancing test is normally required after matching to ascertain whether the differences in the covariates in the two groups in the matched sample have been eliminated, in which case the matched comparison group can be considered as credible counterfactual (Caliendo and Kopeinig, 2008).

### *3.3 Estimating net revenues*

PSM was used to assess the impact of participation on the net income from poultry production. Most of these smallholder farmers do not generally keep proper records of revenues and costs and therefore estimates were made based on the farmers' responses about input usage and sales made. Total revenues earned included revenue from sale of full grown birds (which is equal to the total number of chicks kept by the farmer less the approximate number of chicks which died during the cycle multiplied by the selling price per bird) and revenue from sale of manure and empty feed bags. Costs incurred during the cycle were categorized in to production and transaction costs. Production costs were categorized in to; feed costs (broiler starter, broiler finisher and pellets), cost of vaccines and medication (new castle, gumboro, fowl typhoid, vitamin supplements, deworming drugs and any other medication that the farmer may have used), labor costs and other costs which includes electricity, charcoal, litter (wood shavings) , water and any other cost the farmer may have incurred. Labor costs were estimated from the number of hours put in to poultry production (including both family and hired labor). The wage rate applicable in the area was applied in estimating the hired labor cost. The family labor cost was also imputed from these rates though lower. Transaction costs, on the other hand, included phone call costs and transport cost incurred in search of markets, negotiation and enforcement of contracts. However in this study, most of the transaction costs incurred by the farmers were in search of markets and in enforcement of contracts (follow up in cases of delayed or defaulted payment agreements). The net income value considered was total revenue net off all production and transaction costs.

*3.4 Data and sampling*

To analyze the impact of contract farming on the income of small holder commercial poultry farmers, primary data was collected using pre tested questionnaires in Nakuru County. Nakuru County was chosen because it had smallholder contracted farmers. Primary data was collected from poultry farmers in Nakuru County stratified by participation in contract farming. The list of farmers and their location was obtained from the day old chick suppliers in Nakuru which include Kenchic, Muguku and Sigma. A list of the contracted farmers was also obtained from KPCC. Based on these lists the farmers were placed into various administrative divisions and six divisions with a considerable number of both contract and independent poultry farmers were purposively selected. The selected divisions were Bahati, Njoro, Dundori, Nakuru Municipality, Nakuru North and Elburgon. A complete list of all the villages in the divisions was then drawn and 39 villages randomly selected. Again, a complete list of poultry farmers in the 39 villages were drawn out of which a random sample of 180 households stratified by participation in contract production was randomly selected. Of the 180 households 111 are independent (non-contracted) growers and 69 were contracted farmers.

The survey was conducted on May 2011. However the data on production was for the period November 2010 to February 2011 and was based on the farmer's latest production cycle. Information collected included demographic characteristics of the household, land and asset endowments, access to infrastructure (roads, electricity, water, and telephone), information on revenue earned and cost incurred in poultry production, transaction costs and information on the household farm and nonfarm income. Information on the nature of contract was also collected from contracted farmers.

To obtain Information on the risk perception of the farmer a proxy for risk tolerance based on individual's response to hypothetical risky choices was applied, following Kimball *et.al* (2007). The questions were addressed as a hypothetical gamble. In particular, farmers were asked to choose between a crop/livestock with a certain lifetime income and a crop/livestock with uncertain but higher income. The uncertain income was made to change from a higher amount to a lower amount and the farmer's choice (depending on how much risk he/she was willing to take) based on the expected changes in income. After obtaining the farmers responses farmers' risk attitude was categorized into risk-averse, risk neutral and risk-loving. This study unlike some studies on risk did not intend to go ahead and translate the ordinal responses to cardinal proxies of risk. The dependent variable in model estimated to examine the drivers of participation in poultry production contract is *Kims* which a dummy variable equal to 1 if a farmer is in a contract with Kims, 0 otherwise.

The independent variables were: Family Size = number of household members Experience = experience of the farmer in contract farming in years; Education = number of formal years of education of the farmer; Gender = dummy variable equal 1is farmer is male, 0 otherwise; Age Composition = number of household members aged 15 years and above; Occupation = Dummy for main occupation of the farmer: 1 if farming, 0 otherwise; Risk Altitude = farmer's risk perception: 0 if risk-loving, 1 if risk neutral, and 2 if risk-averse; Farm Size = size of the farm land in acres; Total Assets = Natural log of total asset value of the farm in Kenya Shillings; Brooder Capacity = full brooder capacity of the farm.(number of chicks that the farm's brooders can hold when completely full; Credit = Dummy equal 1 if the farmer received credit for poultry production, 0 otherwise; Group Membership = dummy equal 1 if farmer is a member of a farmers' association, 0 otherwise; Farm Income = natural log of household farm income during 2010; Non-farm Income = natural log of non-farm income earned by the household in 2010; Distance = distance to the main road in kilometers; Extension = Dummy equal 1 if farmer received technical advice during last cycle, 0 otherwise.

## 4.0 Results

### *4.1. Characteristics of Poultry Farmers in Nakuru County*

Table 1 presents summary statistics for the key variables in the data collected. It shows the means of these variables and also the t-tests of differences in mean. As shown by the t- test of mean differences contract farmers have, on average, significantly higher levels of farm and non-farm incomes compared to the independent growers. They also have, on average, significantly shorter production cycles. The t tests also show that the contract farmers and independent farmers differ significantly with respect to distance to the main road, asset value and also the average weight of full grown birds.

**Table1 Summary statistics of contracted and independent poultry farmers in Nakuru**

| Variable | Independent farmers ( N=111) | | Contract farmers (N=69) | | Test of significance |
|---|---|---|---|---|---|
| | Mean | std dev | Mean | std dev | p value |
| Distance to the main road | 2.98 | 2.75 | 2.02 | 1.54 | 0.08* |
| Distance to town (Nakuru) | 14.35 | 7.21 | 15.84 | 8.64 | 0.212 |
| Distance to the vet clinic | 5.16 | 2.35 | 4.62 | 3.33 | 0.207 |
| Distance to the credit society | 7.08 | 3.35 | 7.68 | 4.65 | 0.315 |
| Distance to nearest animal feed | 2.30 | 2.19 | 2.07 | 1.66 | 0.468 |
| Distance to nearest processor | 2.62 | 1.46 | 2.29 | 1.10 | 0.106 |
| Household size | 4.21 | 1.51 | 4.33 | 1.35 | 0.571 |
| Farmers' age | 46.69 | 10.45 | 46.83 | 9.44 | 0.918 |
| Years of farmers' education | 12.23 | 3.08 | 12.64 | 2.75 | 0.365 |
| Land size in acres | 1.11 | 1.00 | 1.27 | 1.18 | 0.349 |
| Full brooder capacity | 624.77 | 550.99 | 684.2 | 627.36 | 0.506 |
| Natural log of total asset value | 11.22 | 1.49 | 11.62 | 1.55 | 0.084* |
| Average weight per bird (Kg) | 1.45 | 0.1 | 1.38 | 0.06 | 0.000*** |
| No of birds kept by farmers | 362.16 | 112.66 | 389.9 | 122.97 | 0.127 |
| Natural log of farm income | 3.56 | 5.51 | 5.21 | 6.08 | 0.05** |
| Natural log of non farm income | 6.02 | 6.34 | 8.41 | 6.22 | 0.014** |
| Length of production cycle (week) | 6.01 | 0.46 | 5.88 | 0.4 | 0.049 |
| Number of feeders | 14.45 | 7.46 | 15.51 | 5.89 | 0.319 |
| Number of drinkers | 12.14 | 6.8 | 12.91 | 5.35 | 0.426 |
| Household member >15 years | 3.56 | 1.48 | 3.58 | 1.54 | 0.896 |

*4.2 Factors influencing farmers' participation in contract farming among the commercial poultry farmers*

Table 2 presents the maximum likelihood estimates and the marginal effects from the Logit regression. Among all the exogenous variables considered, age, education, farm income, off-farm income, gender, distance to the main road, risk altitude and education significantly influenced the probability of participation in poultry contract farming at least at the 10 percent level (Table 2). The model diagnostics indicate that it fits the data well (p value= 0.000). A good fit as measured by Hosmer and Lemeshow's test will yield a large p-value, therefore the Hosmer and Lemeshow's goodness-of-fit test also indicates that the model fits the data well since (P value=0.99).

**Table 2 Logit regression results of factors affecting participation in production contract**

| | **Maximum likelihood estimates** | | | **Marginal effects** | |
|---|---|---|---|---|---|
| **Variable** | **Coefficient** | **S.E** | **p-value** | **Coefficient** | **p-value** |
| Distance to the main road | -0.229** | 0.089 | 0.011 | -0.049*** | 0.009 |
| Education | -0.135* | 0.079 | 0.088 | -0.029* | 0.082 |
| Experience | -0.489 | 0.052 | 0.348 | -0.010 | 0.346 |
| Occupation | 0.215 | 0.534 | 0.688 | 0.045 | 0.684 |
| Gender | 1.096*** | 0.428 | 0.010 | 0.221*** | 0.010 |
| Age composition | -0.068 | 0.121 | 0.574 | -0.014 | 0.575 |
| Land size | -0.19 | 0.185 | 0.283 | -0.042 | 0.290 |
| Risk attitude | 1.67*** | 0.377 | 0.000 | 0.355*** | 0.000 |
| Credit | 0.476 | 0.633 | 0.452 | 0.107 | 0.474 |
| Extension | -1.056* | 0.569 | 0.063 | -0.190** | 0.027 |
| Asset value | 0.071 | 0.15 | 0.636 | 0.015 | 0.632 |
| Farm income | 0.113*** | 0.04 | 0.005 | 0.024*** | 0.007 |
| Non-farm income | 0.135*** | 0.041 | 0.001 | 0.029*** | 0.001 |
| CONS | -3.03 | 2.02 | 0.134 | | |

*significant at 10% **significant at 5% and *** significant at 1%
Overall P-value = 0.000; Pseudo $R^2$ = 0.299; Hosmer-Lemeshow's test (p-value) = 0.9929

As expected, the risk attitude positively and significantly influenced the likelihood of participating in contract production at 1 percent level of significance (Table 2). This means that risk-averse farmers are more likely to participate in contract farming than their counterparts. In theory contract farming is viewed as a means of hedging against risks and that risk-averse farmers will tend to participate in marketing arrangements that diversify (reduce) risks such as futures markets. The marginal effect results indicate that farmers who have a higher risk-rating have a higher likelihood of participating in contract farming by 0.36 (Table 2). Hence our finding is line with theory. Indeed risk reduction is usually a major objective of contract farming (Martin, 1995).

The distance covered by the farmer to access the main road negatively influenced farmers' participation and was significant at the 5 percent level (Table 2). This implies that the further away the farm is from the main road the less likely the farmer will participate in contract production. A 10 percentage increase in the distance from the main road would reduce the probability of participating in contract farming by 0.5 (Table 2). This finding is perhaps due to the fact that the contracting firm (Kims) prefers to work with farmers who are near the main roads due to ease of reaching such farms.

The levels of farm and non-farm incomes positively and significantly influenced the decision to participate in poultry contract faming and were significant at least at the 1 percent level (Table 2). A percent increase in the farm income and also in non-farm incomes of a farmer will increase the likelihood of the farmer to participate in contract farming by 2 and 3 percent respectively. This finding suggests that farmer's financial endowment increases the probability of participating in contract farming. The finding that households with higher levels financial endowments are more likely to participate in contract farming than their counterparts suggests that contract farming can exclude poor farmers.

The gender of the respondent is also positive and significant indicating that the probability of participating in contract farming at the 1 percent level (Table 2). In particular, the results show that male farmers have a higher probability of participating in contract farming than their female counterparts.  The marginal effect results indicate that for male farmers the probability of participating in contract farming is higher than for the female farmers by 0.22. The finding may be due to the disproportionate ownership of productive assets by males in general in Kenya.

Contrary to our expectation, households which received technical advice from extension agents were less likely to participate in contract farming. Extension had a negative influence on the farmer's likelihood of participation in poultry contract farming and was significant at the 10 percent level (Table 2). The results indicates that the probability of participating in contract farming for those farmers who access advice is lower by 0.19 compared to those farmers who have no access to these services. This finding however suggests that farmers who obtain technical advice from government extension agents are likely to be more aware and informed of alternative marketing channels and also production methods.

The level of education of the farmer however has a negative influence on the farmer's likelihood to participate in contract farming but was significant at the 10 percent level (Table 2). Results show that an increase in years of education by 1 year will reduce the likelihood to participate in contract farming by 0.14. The negative influence may be due to the fact that more educated farmers are more open to other marketing channels in the region such as the hotels, brokers and so on.

*4.2 Impact of contract farming on the net income per bird.*

To assess the impact propensity score matching (PSM) was applied. The results of the initial step in PSM used in estimating the propensity scores (which employs a Logit regression) are shown in the Table 3.

**Table 3 Maximum likelihood estimates of the logit regression used in estimating the propensity scores**

| Variable | Coefficient | Std Error | P-value |
|---|---|---|---|
| Distance to the main road | 0.208** | 0.09 | 0.021 |
| Experience | -0.052 | 0.055 | 0.339 |
| Education | -0.148* | 0.089 | 0.096 |
| Occupation | 0.384 | 0.516 | 0.456 |
| Gender | 0.906** | 0.415 | 0.029 |
| Age composition | -0.072 | 0.13 | 0.581 |
| Land size | -0.165 | 0.178 | 0.354 |
| Risk attitude | 1.65*** | 0.365 | 0.000 |
| Credit | 0.120 | 0.601 | 0.485 |
| Extension | -0.968* | 0.549 | 0.078 |
| Capacity | 0.001 | 0.001 | 0.795 |
| Asset value | 0.072 | 0.157 | 0.644 |
| Farm income | 0.114*** | 0.040 | 0.004 |
| Nonfarm income | 0.121*** | 0.38 | 0.001 |
| CONS | -3.92*** | 1.135 | 0.001 |

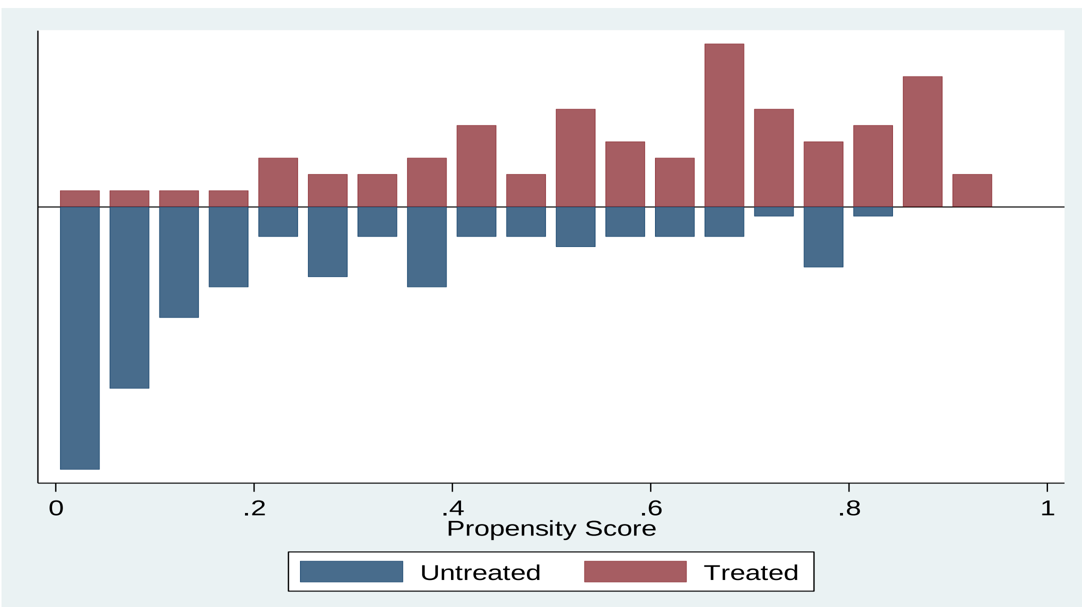
*significant at 10% **significant at 5% and *** significant at 1%;

Pseudo $R^2$ = 0.292; P value = 0.000

The likelihood ratio test of goodness of fit indicates that the model fits the data well (p value =0.000). Furthermore results of the maximum likelihood estimation of the Logit show that distance of the farm to the main road, gender of the farmer, risk perception of the farmer, receiving advice from extension agent, farm income and non-farm income are significant factors in explaining the farmers' participation in contract farming. Hence individuals participating in contract farming differ significantly from the non-participants with respect to observable characteristics suggesting that there is self-selection. Therefore 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.

Propensity scores were estimated for all the 180 farmers including 111 independent growers (control) and 69 contracted farmers (treatment). Among participants, the predicted propensity score ranges from 0.0347 to 0.9311, with a mean of 0.5809. While the predicted propensity score ranges from 0.0068 to 0.8450, with a mean of 0.2543 among non-adopters. The density distribution of the propensity scores for participants and non-participants is shown in (Figure 1) below. 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 indicates the frequency of the propensity score distribution. Visual analysis of the density distribution of the propensity scores suggests that there is a high chance of getting good matches and that large number of matched sample size from the distribution as the propensity score distribution is skewed to the left for participants and to the right for the non-participants.

Figure1: Propensity score histogram




The graph shows that no treated individuals were off support indicating that all the individuals that participated in contract farming (treated) found a suitable match among those who did not participate (control

Table 4 presents the results of the covariate balancing test to test the hypothesis that that both groups have the same distribution in covariates *x* after matching. It presents the covariates' means, their t-test of differences in means as well as the percentage bias before and after matching. For all the 13 covariates, the matched sample means are almost similar for both the treatment and the control which was not the case prior to matching

**Table 4 Propensity Score and Covariate Balancing**

| | | **Mean** | | **% bias reduction** | | **T test differences in means** | |
|---|---|---|---|---|---|---|---|
| **Variable** | **Sample** | **Treated** | **untreated** | **% bias** | **\|bias\|** | **T stat** | **p- value** |
| Pscore | Matched | 0.5909 | 0.2543 | 145.5 | | 9.42 | **0.000** |
| | unmatched | 0.5909 | 0.5685 | 9.7 | 93.4 | 0.61 | 0.540 |
| Distance to the main road | Matched | 2.0232 | 2.9856 | -43.3 | | -2.66 | **0.008** |
| | unmatched | 2.0232 | 2.198 | -7.9 | 81.8 | -0.63 | 0.529 |
| Education | Matched | 12.638 | 12.225 | 14.1 | | 0.91 | 0.365 |
| | unmatched | 12.638 | 12.937 | -10.3 | 27.4 | -0.64 | 0.525 |
| Experience | Matched | 5.7391 | 6.2973 | -12.4 | | -0.81 | 0.421 |
| | unmatched | 5.7391 | 6.1638 | -9.4 | 23.9 | -0.57 | 0.572 |
| Occupation | Matched | 0.5507 | 0.6396 | -18.1 | | -1.18 | 0.238 |
| | unmatched | 0.5507 | 0.5391 | 2.4 | 87.0 | 0.14 | 0.892 |
| Gender | Matched | 0.6957 | 0.5225 | 35.8 | | 2.32 | **0.022** |
| | unmatched | 0.6957 | 0.7232 | -5.7 | 84.1 | -0.35 | 0.724 |
| Age composition | Matched | 3.6522 | 3.6216 | 2.0 | | 0.13 | 0.896 |
| | unmatched | 3.6522 | 3.7406 | -5.8 | -189.4 | -0.34 | 0.733 |
| Land size | Matched | 1.2652 | 1.1108 | 14.1 | | 0.94 | 0.349 |
| | unmatched | 1.2652 | 1.3334 | 12.1 | 14.6 | 0.74 | 0.460 |
| Brooder capacity | Matched | 684.2 | 624.77 | 10.1 | | 0.67 | 0.506 |
| | unmatched | 684.2 | 793.91 | -18.6 | -84.6 | -1.00 | 0.321 |
| Risk attitude | Matched | 1.8261 | 1.1802 | 95.7 | | 5.92 | **0.000** |
| | unmatched | 1.8261 | 1.8116 | 2.1 | 97.8 | 0.18 | 0.856 |
| Credit | Matched | 0.1594 | 0.1171 | 12.2 | | 0.81 | 0.420 |
| | unmatched | 0.1594 | 0.1551 | 1.3 | 89.0 | 0.07 | 0.945 |
| Extension | Matched | 0.1015 | 0.2172 | -29.4 | | -1.86 | **0.065** |
| | unmatched | 0.1015 | 0.1015 | 0.0 | 100.0 | 0.00 | 1.000 |
| Asset value | Matched | 11.623 | 11.217 | 26.6 | | 1.74 | **0.083** |
| | unmatched | 11.623 | 11.449 | 11.4 | 57.2 | 0.67 | 0.506 |
| Farm income | Matched | 5.2842 | 3.5614 | 29.7 | | 1.96 | **0.051** |
| | unmatched | 5.2842 | 5.0663 | 3.8 | 87.4 | 0.21 | 0.833 |
| Non farm income | Matched | 8.411 | 6.0179 | 38.1 | | 2.48 | **0.014** |
| | unmatched | 8.411 | 7.6693 | 11.8 | 69.0 | 0.70 | 0.485 |
| (Figures in bold shows significant covariates) | | | | | | | |

Attainment of covariate balancing for this study is also indicated by the tests of differences in means shown in Table 5 below in the last column. Table 5 shows that with matching those covariates whose differences were statistically significant prior to matching have been balanced such that after matching there are no longer statistically significant. These are those variables whose *p* values are in bold and they include distance to the main road, risk attitude, gender, farm income, non farm income, total asset value and extension, (all were balanced such after matching none was significantly different). Matching makes the covariates comparable by balancing them for the two groups and by doing this reduces the selection bias.

**Table 5 Other Covariate Balances Indicators Before and After Matching**

| Test indicator | |
|---|---|
| *Before matching* | |
| Pseudo $R^2$ | 0.292 |
| LR $\chi 2$ (P value) | 69.93(0.000) |
| *After matching using nearest neighbor matching (NNM)* | |
| Pseudo $R^2$ | 0.028 |
| LR $\chi 2$ (P value) | 5.35(0.967) |
| *After matching using kernel based matching (KBM)* | |
| Pseudo $R^2$ | 0.04 |
| LR $\chi 2$ (P value) | 7.67(0.864) |
| *After matching using radius matching (RM)* | |
| Pseudo $R^2$ | 0.051 |
| LR $\chi 2$ (P value) | 9.74 (0.715) |

Low pseudo-R2 and the insignificant likelihood ratio tests further support the hypothesis that both groups have the same distribution in covariates *x* after matching. These results clearly show that the matching procedure is able to balance the characteristics in the treated and the matched comparison groups. Therefore these results were used to evaluate the impact of contract farming on the bird's net income among groups of households having similar observed characteristics.

Together, the results of these tests indicate absence of hidden bias which implies that the computed ATT estimates are valid given the sample.

**The treatment effect (impact)**

The impact of participating in contract farming on poultry income computed using the three matching algorithms namely, nearest neighbor matching (NNM), kernel based matching (KBM) and radius matching (RM) are shown below in Table 6. The outcome variable was the net income per bird (net of all production costs and transaction costs) in Kshs. The impact of participation is shown by the difference in ATT shown in bold in the table 6 below.

**Table 6 Impact of participation in contract production of poultry**

| Matching algorithm | Sample | Treated | Control | Difference | T –stat |
|---|---|---|---|---|---|
| | unmatched | 33.65 | 27.76 | 5.90 | 2.21 |
| Nearest neighbour matching | ATT** | 33.65 | 25.74 | **7.91** | 2.19 |
| | ATU | 27.76 | 32.90 | 5.14 | |
| | ATE | | | 6.20 | |
| Kernel based matching | ATT** | 33.65 | 26.87 | **6.78** | 2.04 |
| | ATU | 27.76 | 32.58 | 4.38 | |
| | ATE | | | 5.58 | |
| Radius Matching | ATT** | 33.65 | 26.73 | **6.93** | 2.19 |
| | ATU | 27.76 | 33.41 | 5.66 | |
| | ATE | | | 6.14 | |

*significant at10% **significant at 5% ***significant at 1%

The results indicate that, participating in contract farming has a positive and significant impact on the incomes of the farmers at the 5 percent level (Table 6). This is achieved through the increment in the net revenues from bird sale. The impact for these farmers is an increment in net revenue per bird of Kshs 7.91, Kshs 6.78 and Kshs 6.93 using NNM, KBM and RM matching algorithms respectively which are significant at 5 percent. It can therefore be concluded that the impact of participating in contract farming is an increment of net revenue per bird of approximately 27 percent on average. This finding suggests that getting smallholder commercial poultry farmers to participate in contract farming can help improve their welfare through increasing the net revenues from these birds and thereof incomes.

**Sensitivity analysis for hidden bias**

The propensity score matching model applied above assumes that the differences between the participants and the non-participants is just because they differ in observable variables in the data set that is the conditional independence or the unconfoundedness assumption. However if the two comparison groups differ in unobservable characteristics the conclusion of the positive effect of participation in contract farming on the net income from birds may be questionable. The purpose of the sensitivity analysis is to ask whether inferences about participation effects may be altered by factors not observed in the data set (unobserved variables).

Since it is not possible to estimate the magnitude of selection bias while using PSM (non-experimental model) Aakvix (2001) suggests the use of Rosenbaum bounds (rbounds) test which tests the null hypothesis of no effect on the treatment effect for different values of unobserved selection bias. This study therefore conducted the sensitivity analysis for the presence of hidden bias using the Rosenbaum bounds (rbounds test) in STATA 11. This sensitivity test shows how hidden biases might alter inferences about treatment effects but does not indicate whether biases are present or what magnitudes are plausible

The level of gamma is defined as the odds ratio of differential treatment assignment due to an unobserved covariate. Table 7 below shows the level of gamma for the three matching algorithms. Both the KBM and the RM approach reported a level of gamma of [2.15, 2.2] while the level of gamma in NNM is [2.3, 2.35]. In all the three matching algorithms the lowest gamma level is 2.15 and the highest level is 2.35. For a gamma level of 2.15 it implies that if individuals who have the same characteristics ($\chi$ vector) differs in their odds ratio of participation by a factor of 115 percent then the significance of the estimated participation effect on net income may be questionable

**Table 7 Results of the sensitivity analysis for the hidden bias**

| **Matching method** | **ATT** | **T statistic** | **Gamma (γ) level** |
|---|---|---|---|
| Nearest neighbour | 7.90 | 2.19 | 2.3-2.35 |
| Kernel Based | 6.78 | 2.04 | 2.15- 2.2 |
| Radius Matching | 6.93 | 2.19 | 2.15- 2.2 |

(The gamma level is reported at the point where 10% level on (sig +) is exceeded)

Generally, the gamma levels reported for sensitivity analysis are in the range and they compare favorably with those reported in other studies (e.g. Faltermeier and Abdulai, 2009, Ali and Abdulai, 2009). It can therefore be concluded that even large amounts of unobserved covariates would not alter the conclusion about the estimated effects and that the positive treatment effects reported in table 6 above can be attributed to participation in contract farming and not due to unobserved variables

**5.0 Summary, conclusion and policy recommendation**

This study examined the factors influencing farmers' participation in contract farming and evaluated the impact of contract farming on the net revenue from broiler production in Nakuru County of Kenya among the smallholder farmers. Comparison was made between two groups of farmers namely independent farmers and contracted farmers by an agribusiness firm called Kims poultry farm care. A sample of 180 farmers selected using the multi-stage sampling procedure were interviewed using semi-structured questionnaires and the data analyzed in Stata.

The findings indicate that risk–averse farmers were more likely to participate in poultry contract farming. Farm and non-farm income also have positive influence on the likelihood of participating in contract farming while male farmers have a higher likelihood of participating in contract compared to the female farmers. The study further finds that distance of the farm from the main road as well as the farmer's level of education were found to negatively influence farmers' likelihood to participate in contract production. Farmers who receives advice from the extension agents are however less likely to participate in contract farming. Results of impact assessment, as given by average treatment effect on the treated (ATT), show that participating in contract farming has a positive and a significant effect on the net revenue per bird. The increment in revenue was found to be approximately 27 percent of the net revenue that these farmers would have received if they had not participated in contract farming. Furthermore results from the sensitivity (rbounds) test of hidden bias showed that even large amounts of unobserved covariates would not alter the conclusion about the estimated effects and that the treatment effects estimated are purely as a result of participation in contract farming.

The study concludes that participation in contract production indeed improves the welfare of participating farmers. The implication of these findings is that contract farming can reduce rather than entrench rural poverty as some studies have suggested. Policies which will make it easier for smallholder farmers to participate in contract farming should be pursued. These include policies that target improvement of rural infrastructure especially roads. The finding that poor farmers are less likely to participate in farming due to risks involved calls for policies and strategies that target the inclusion of such farmers in contract production. One such strategy is to help such farmers form producer organizations that will allow then overcome financial barriers and idiosyncratic market failures.

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